POWER

Volume 66 New York, November 8, 1927 *Number 19*

The Smoke Nuisance

DID you ever try to grow flowers under a tree? Did you ever try to make blueprints or print negatives by a poorly lighted window? Did you ever see the prison pallor?

Just as there are sounds so shrill and vibrations so slow that the human ear cannot hear them, so there are light waves so short and light waves so long that the human retina cannot register them. Away up beyond the visible part of the spectrum in the ultra violet are rays that affect photographic plates and perform all sorts of physical and chemical wonders.

These rays are essential to healthy vegetable and animal growth. They come not only from the sun, but from the whole firmament. When we shut off the overhead light, we stunt organic development and we know not what biological and sanitary processes in the microscopic processes of nature.

Dr. James E. Ives, of the U. S. Bureau of Public Health Service, says that on an average bright day the smoke and vapor hanging over New York deprive the city of 37 per cent of its sunlight in the early morning and 14 per cent at high noon.

The smoke nuisance, then, is not only an offense to sight and nostrils, a question of begrimed buildings, soiled carpets and hangings, depreciated shelf stocks, speckled lungs and big laundry bills, but a screen between us and the heavens from which cometh our strength.

And it is in the main preventable.

Coal, even soft coal, can be burned without objectionable smoke. Smoking chimneys mean not only niggardliness or carelessness or ignorance in providing proper furnaces and combustion apparatus, but inefficiency in the use of fuel.

The public health as well as æsthetics, cleanliness, economy and the preservation of the city as a goodly place in which to work and live demand the suppression of the evil.

F. R. Low

Design of Lincoln Park Heating Plant Permits Future Power Generation

By K. B. CASTLE
Rochester Gas & Electric Corporation

THE Rochester Gas & Electric Corporation has under construction at Rochester a new high-pressure central heating plant that will ultimately deliver both steam and electric energy

FOR a considerable time the Rochester Gas & Electric Corporation, of Rochester, N. Y., has been selling steam for heating and process work from its main generating station to surrounding factories and office buildings. In the summer of 1924 a survey was made of the business district of the city, and it was decided to build a station in this district to supply low-pressure steam for heating and steam at 100 lb. gage for industrial use. Steam was to be generated at 380 lb., passed through a turbine and exhausted at 5 to 20 lb. for the low-pressure heating. The power to be generated by the turbine would be purely a byproduct depending upon the available low-pressure load. The industrial load anticipated did not warrant the installation of a bleeder turbine, so reducing valves were used to lower the boiler pressure to a little above the 100 lb. desired at the customer's valve.

This station, described in the article, "Combined High-Pressure Power and Heating Plant," by R. D. DeWolf, *Power*, Dec. 1, 1925, was put into commercial operation in the latter part of October, 1925. The first season's results at this station were so favorable that a survey of the city for a location of a second similar plant was made. As a result it was decided to build a plant in the center of a promising industrial locality where the company already had an electrical substation and considerable available land.

The new building, approximately 109 ft. long by 70 ft. wide and 85 ft. high, will house two boilers. Land is available for increasing the size of the building to an ultimate capacity of eight boilers when the load demands. The present building has a turbine room large enough for one 3,000-kw. machine, but owing to the uncertainty as to type of load none will be installed at present.

BOILERS AND FURNACES

The boilers contain 9,580 sq.ft. of heating surface with 1,639 sq.ft. of integral economizer. They are straight-tube, vertical single-pass type designed for 384 lb. pressure. Provision has been made for the addition in the future of water-cooled side and rear walls and a water screen across the bottom of the furnace. The superheaters are designed to give 98 deg. F. of superheat at a flow of approximately 70,000 lb. of steam per hour.

Contrary to general practice the entire boiler setting, except for the ashpit and soot hopper under the rear sections of the boiler, is of hollow wall construction. On the vertical walls the hanger brick is clamped to 6-in. vertical I-beams on 18½-in. centers. The inner brick is held to the hanger brick by grooves in its side, as may be seen by the shape of the brick in Fig. 2. Every fourth hanger brick is supported on a clip to the 6-in. I's and is slightly longer than the others with a correspondingly short inner brick. This enables a section of the wall to be removed without disturbing the bricks above it. The lower 16 ft. of the side walls of the combustion chamber slope out approximately one foot, thus giving a greater width at the bottom of the furnace where the flame turns upward, and where width is needed. This undercut wall also keeps freer from clinkers than a vertical wall.

The brick of the horizontal suspended arch is held by 4-in. I's on 18½-in. centers, while the inclined arch is held by 4-in. I's on 14½-in. centers with smaller inner brick to match the 29-in. spacing of the boiler drums. A transite covering is placed outside of the I-beams, thereby providing air passages for preheating air for combustion. The space between I's around the boiler and on the rear wall of the furnace is to be packed with a Rock Wool packing. A careful study of the cost of this construction as against plain brick lined with firebrick was made, and it was found that, although the cost per square foot for material was higher, the cost of setting up the wall was considerably lower and the total cost was slightly in favor of the arch construction type. It was also felt that this construction makes a superior wall.

The ashpits are of reinforced concrete, brick-lined and supported on structural steel hung from above. The sides are vertical; the front and rear slope in at a very steep angle. Four hand-operated ash gates are provided per boiler.

A sluicing system is provided that carries the ash to a settling tank from which it will be removed and dumped into gondola cars on the railroad siding by the clamshell bucket of a gasoline-operated caterpillar hoist. The separating tank has sufficient storage capacity to fill one car.

One mill of 2,600 lb. per hour capacity and one of 8,500 lb. are being installed per boiler. Space is allowed for adding a second 8,500-lb. mill when the load de-

mands. Each mill is equipped with a separately driven feeder. On the small mill both the coal and the air are admitted radially, while on the large mill the coal is fed radially and the air axially. The exhauster for the small mill is mounted on the mill shaft, while that for the large mill is on the floor above and is driven separately. Both the large and the small mills have a classifier between the mill and exhauster. Each large mill feeds two burners, the small mill, one. Allowance is made for admitting air to the exhauster fans without passing it through the mill. This is considered desirable as it maintains a high air velocity through the burner with a low velocity through the mills. This materially aids operation under light loads.

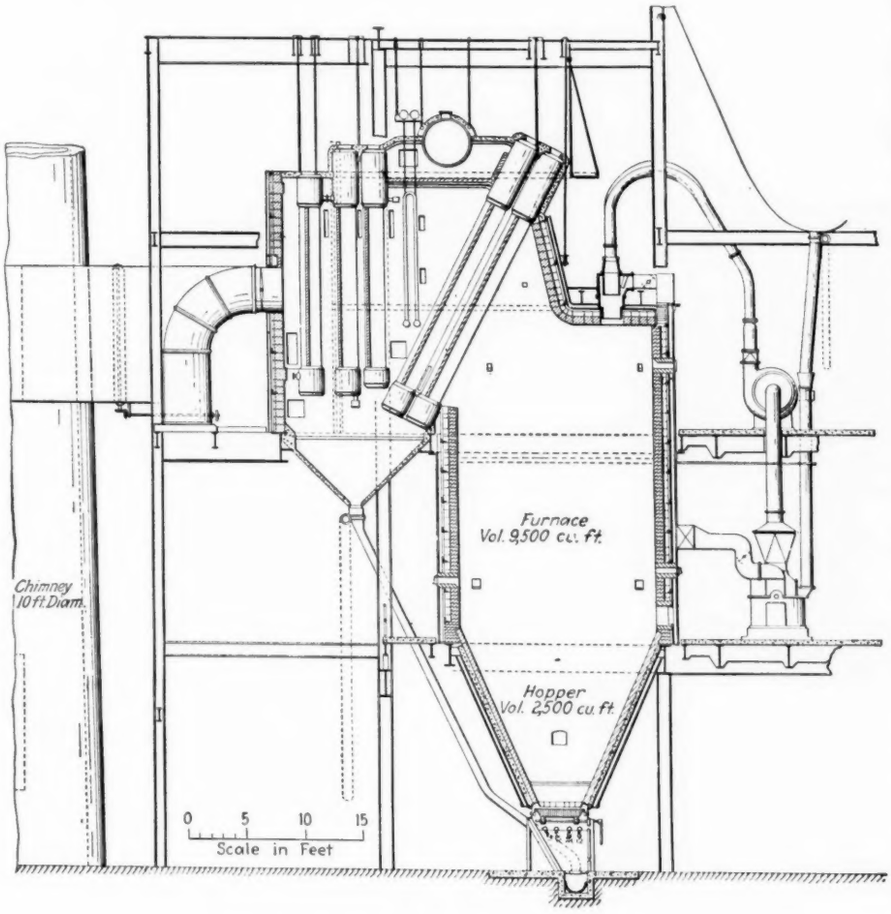

Fig. 1—Sectional elevation of boiler house

The air for the mills will be preheated to about 175 deg. F. by being drawn through the air passages in the front wall of the furnaces. This preheating of the primary air will aid combustion, increase the capacity of the mill when handling wet coal, and will materially reduce the power consumption. It is expected this amount of preheat will reduce the moisture in the coal while passing through the mill from approximately 5 per cent in the raw slack to 1.25 in the powdered coal.

Most of the secondary air for combustion will be drawn from the side walls by natural draft and admitted around the burners. However, when the load increases a blower will be installed to draw the air from the side walls and blow it into the furnace. Auxiliary air openings are provided near the bottom of the front wall to allow additional secondary air to enter during peak loads.

Future secondary air ports will be installed between the burners to allow more air to enter around the coal stream without carrying the excess pressure that would be required if all were forced through the burners.

Coal Handling

Coal dumped from gondola cars into a track hopper is fed to an inclined belt conveyor by a plate feeder, and dumped over a magnetic pulley into a hopper above a single-roll coal crusher. A two-way chute enables the coal crusher to be bypassed. From there it is carried by a vertical bucket belt conveyor to a horizontal belt conveyor running through a monitor above a 725-ton coal bunker.

The control of the coal-conveying equipment is such that a failure in any section will automatically stop preceding, but not succeeding, equipment. To safeguard against the danger of leaving the magnetic pulley on when the belt conveyor is not running, the power for the magnetic pulley is obtained from a motor-generator set that receives its power from the line to the first belt-conveyor motor beyond its oil switch. All coal-equipment conveyor motors are totally inclosed, squirrel cage.

The flue gas passes directly from the boiler into the stack through a separate opening for each boiler. Provision is made for the future installation of separate economizers. The gas will then leave the boiler and pass down through the economizer to an induced-draft fan on the ground floor and enter a second pair of openings just above the base of the stack. The present stack connection will then be used as a bypass for the economizer and fan.

The stack, 10 ft. inside diameter at the top by 230 ft. high, is built of reinforced concrete.

Feed Water

The returns from the system are pumped from the customers to a return tank, where the city water make-up is added. From this tank the feed water is pumped by a low-head pump through a deaërator which also acts as a second storage tank into which city water may be admitted through a float control valve if the water level falls below the desired limit. From the deaërator the water passes by gravity to the boiler feed pumps, of which there are two, a 500-g.p.m. turbine-driven pump and a 300-g.p.m. motor-driven pump. The speed of the 500-gal. pump is controlled by a differential pressure regulator set to maintain a constant pressure difference between the feed and the steam of 50 lb. The

300-gal. pump, as installed, has a 200-gal. impeller which greatly reduces the power required to drive it under light loads and is ample for present loads. The normal speed of this pump is 1,750 r.p.m., requiring a 150-hp. motor.

During the summer, when there is practically no demand for low-pressure steam, the motor pump will be used. During this season the future turbine will be shut down and it will be unnecessary to operate the boilers at full pressure. The pressure may therefore be carried at 150 to 200 lb., which is more than ample for the industrial lines. Under normal speed and practically no load this pump would require approximately 95 hp.; by dropping its speed to 1,150 r.p.m. the head is reduced to about 210 lb. and the power required to 40 hp. The pump is therefore being installed with the 150-hp. 1,750-r.p.m. motor on one end and a 50-hp. 1,150-r.p.m. motor on the other. The only work required in changing from one motor to the other will be to remove the pins in the coupling on one motor and insert those on the other.

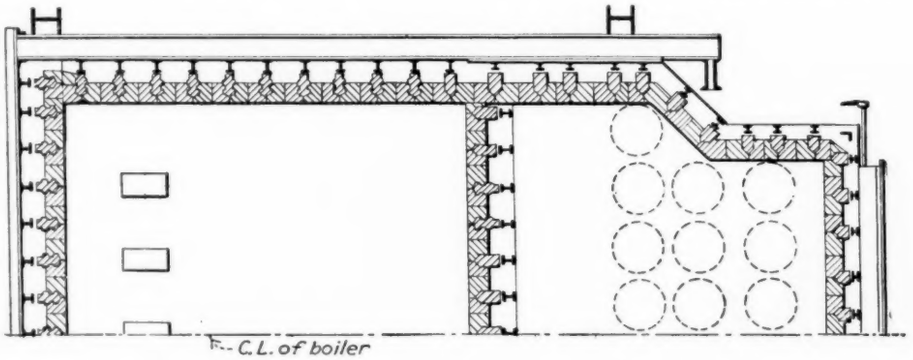

Fig. 2—Plan of boiler setting showing wall construction

Power for operating the station will be brought direct from the adjoining electric substation through a bank of 4,150- to 440-volt transformers to the station distribution bus. As the substation is strictly automatic and has no operator on duty, the oil switches for the lines to the generating plant will be operated by remote control from the plant. The individual oil switches for the different motors are all located on a switchboard gallery in the turbine room with start and stop push-button control beside the individual motors. A stop button is also installed for each motor on the panel board of the operating floor. The question of start buttons on this board was also considered, but the danger of a motor's being started when someone was working on it was considered too great, so they were omitted. All essential motors are designed to start under full line voltage, and no-voltage release coils are being omitted.

The steam mains leave the plant from the turbine room. Those crossing the railroad are carried overhead to the farther side of the tracks on a special bridge, from which point they pass underground to the different customers. The mains to customers on the plant side of the railroad pass directly underground to them.

The general supervision of the design and construction of this station have been under Messrs. R. D. DeWolf, assistant superintendent, electric department; I. E. Powell, superintendent steam generation and steam distribution; S. Firestone, consulting engineer; R. H. McCumber, superintendent of the plant, and the author.

PRINCIPAL MECHANICAL EQUIPMENT FOR THE LINCOLN PARK HEATING PLANT

BOILERS

Make	The Bigelow Company
Type	Vertical Water-Tube
Number installed	2
Boiler pressure, lb. gage	384
Steam temperature, deg. F	540
Water-heating surface, boiler sq.ft.	9,580
Integral economizers	1,639
Total	11,219
Superheater	Power Specialty Co.
Soot blowers	Diamond Power Specialty Co.

FURNACE

Boiler setting	The DeWolf Arch Brick Steel Construction.
Arch brick	Harbison-Walker Refractories Co.
Furnace casing	Johns-Manville
Furnace volume, cu.ft	9,500

COAL-BURNING EQUIPMENT

Pulverized coal system	Combustion Engineering Corp.
Mills, unit type	One—2,600 lb. per hr. per boiler One—8,500 lb. per hr. per boiler
Burners	Combustion Engineering Corp.
Pulverized coal piping	Combustion Engineering Corp.
Air ducts	Flesch & Schmidt.

ASH HANDLING

Hydro jet system	Allen-Sherman-Hoff Co.

STACK

Type	Concrete, lower part brick lined.
Make	Rust Engineering Co.
Height above ground level, ft	230
Diameter of stack, ft	10
Smoke flues	Connery Co.

COAL-HANDLING EQUIPMENT

Conveyors	Erskine-Healey, Inc. Jeffrey Mfg. Co.
Coal crusher	Jeffrey Mfg. Co.
Coal bunker, fabricated by	Pittsburgh Des Moines Steel Co

FEED PUMPS

One—6-stage, 300-g.p.m. pump	Pennsylvania Pump Co.
Motor	Westinghouse Elec. & Mfg. Co.
One—5-stage, 500-g.p.m. pump	Pennsylvania Pump Co.
Turbine	Terry Turbine Co.
One—500-gal. per min. low-head pump	Goulds Mfg. Co.
Motor	Westinghouse Elec. & Mfg. Co.

VALVES and PIPINGS

Steel gate valves	Chapman Valve Mfg. Co.
Steel globe valves	Edward Valve & Mfg. Co.
Check valves	Chapman Valve Mfg. Co.
Boiler stop valves	Elliott Co.
Reducing valves	Ruggles-Klingemann Mfg. Co.
Safety valves	Consolidated Valve
Blowoff valves	Yarnall-Waring Co.
Blowoff valves	Edward Valve & Mfg. Co.
Steam traps	Armstrong
Piping	M. W. Kellogg Co.
Gaskets	Goetze Gasket & Packing Co. Metallo Gasket Co.
Feed-water regulator (Copes)	Northern Equipment Co.
Excess-pressure regulator	Ruggles-Klingemann Mfg. Co.
Gate valves, low-pressure	Lunkenheimer
Float valves	Cochrane Corporation
Atmospheric relief	Cochrane Corporation

MISCELLANEOUS

Deaerator	Cochrane Corporation
Return tank	Leach Steel Co.
Flow meters	Bailey Meter Co.
Pressure recorders	The Foxboro Co., Inc.
Air compressor	Ingersoll Rand

INTERNAL COMBUSTION ENGINES

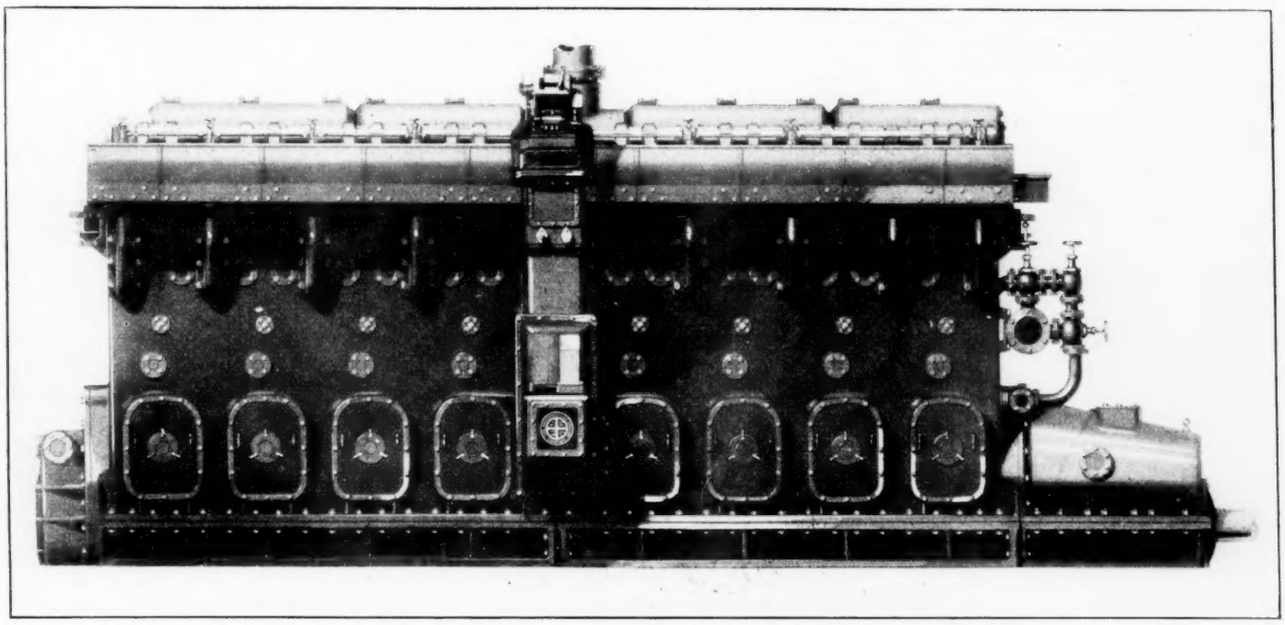

Fig. 1—The 1,500-hp. Bessemer Diesel on the test floor

A 1,500-Horsepower Diesel *of the Solid-Injection Four-Stroke-Cycle Type*

THE largest solid-injection Diesel of the four-stroke-cycle type has completed its 30-day test at the shops of the builder, the Bessemer Gas Engine Co. The engine, along with a second of the same capacity, will be installed on an ocean-going yacht.

Among other unusual features is the speed of 300 to 350 r.p.m. The eight cylinders are 18 in. diameter by 22 in. stroke, giving a piston speed of 1,283 ft. at 350 r.p.m. This is high, even with a longer-stroke design, but is made possible through the use of light-weight pistons and close clearances.

The design, as will be seen from Figs. 1 and 2, embraces the use of the *en bloc* frame. The base is in two pieces held together by machine-finished bolts in reamed holes; in addition an extension of the base carries the bearing beyond the flywheel. On this base is placed the block, consisting of two box members into which are placed the cylinder liners. The base and frame are of cast steel with a view to obtaining strength with lightness.

The crankshaft, $12\frac{3}{4}$ in. in diameter, is of two-piece construction, with a recessed flange joint between the sections. The shaft sections are forged from billets of 35- to 40-point carbon steel. After being annealed, they are rough turned and the throws rough blocked, followed by a second heat treatment. The shaft, after finishing, is drilled for the lubricating oil passage to the crankpins and connecting rods.

TWO 1,500 horsepower Diesels completed by Bessemer Gas Engine Co. —Largest engine of the solid-injection type built—Piston speed close to 1,300 ft. per minute when running at 350 r.p.m.

The main bearings have removable bearing shells provided with dovetail grooves into which the babbitt is anchored after being cast centrifugally. The top and the lower halves are interchangeable,

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thereby doubling the life of a bearing before renewal.

At the shaft flange is placed a two-to-one gear train which drives the overhead camshaft through a sprocket chain consisting of hardened-steel rollers and spreaders.

Each cylinder head, Fig. 4, is provided with two admission and two exhaust valves, along with a centrally placed fuel-spray valve. To insure starting in marine service, each head carries an air starting valve. All the admission and exhaust valves are placed in cages to permit easy inspection and renewal when necessary.

The use of dual valves enables a better cooling effect, which is made still more favorable by the partition in the water cavity of the head, as shown in Fig. 2. The lower gas velocity should reduce valve cutting compared to that occurring with single valves. These valves are made from one-piece alloy steel forging.

The camshaft is supported on brackets at the level of the cylinder heads. This shaft is provided with two sets of cams for each valve, to permit reversing. All the operations in starting and reversing are accomplished through a single lever moving in a U-shaped slot.

When the operator desires to reverse the engine, he moves the control lever along the horizontal portion of the U-slot. This action admits air to one end of a ram which, through a rack and pinion, rotates the camshaft and exhausts the air from the other side of the ram's piston. At the same time a drum cam mounted on the camshaft causes the shaft to shift longitudinally as it rotates, bringing the reverse cams under the valve-rocker rollers. To prevent the rockers from dropping on the shaft during the reversing process, a bar is placed above the cylinder head, against which the rockers contact before they can drop between the cams.

With the camshaft shift completed, the operator moves the lever up along the slot, causing a latch to hook the stem of the air-starting valve, admitting air to the eight cylinders. As soon as the engine is turning over on the air, the control lever is moved farther up along the slot until the air latch is disengaged, whereupon a slight movement of the lever brings the governor wedge, shown in Figs. 2 and 3, between the spray-valve rocker and the spray push-rod. This permits fuel to enter each cylinder and the engine is ready to carry its load.

The constant-stroke system is employed in fuel feed. With this system the fuel pumps maintain a constant pressure of around 4,000 lb. per sq.in. in the fuel manifold, a spill valve returning the excess oil to the pump suction. The spray valve is of the mechanical type; a diagrammatic outline of the valve and actuating mechanism is shown in Fig. 3. This drawing does not show details and is intended to illustrate the principle only.

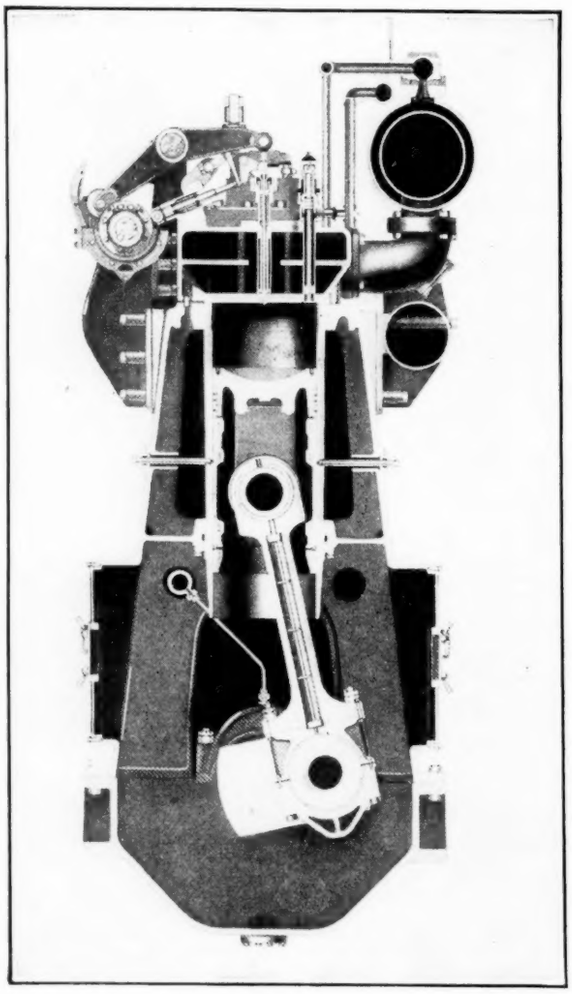

Fig. 2—Cross-section of the engine showing the en bloc construction

As will be seen from Fig. 2, a bracket is bolted to the cylinder head to carry the spray-valve rocker and push rod. The governor control shaft carries wedges which rest between the rocker and push rod of each cylinder. The position of this wedge controls the amount and duration of the lift of the needle valve, and consequently the amount of fuel passing into the cylinder.

To maintain the oil pressure in the fuel lines, a four-plunger pump is used. The drive is through two eccentrics and rockers from the two-to-one gear train in the center of the engine frame. The eccentrics are placed to cause the plungers to work in sequence. This plan has been followed in order to prevent pulsations in the fuel manifold.

The governor control shaft is connected to the operator's control lever, so that manual speed regulation is possible. To prevent excessive speeds a belt-driven over-speed governor, Fig. 5, by varying the pressure in the lubricating oil system, causes an oil ram to shift the governor shaft. The governor control is very sensitive, since the shaft is mounted in ball bearings.

The spray valve is unusual in that in place of the usual taper seat, a flat seat is incorporated in the design. Experience with engines in service indicates that this is as leakage-proof as a taper seat. To avoid the springing that might occur with a long valve stem when spring loaded, the needle spring is placed down in the valve cage as shown.

Owing to the speed of over 300 r.p.m. a light-weight

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piston was adopted; this is the Bu-nite nickel-alloy steel banded design. The crown supports the piston-pin bosses and piston skirt through strut members. The skirt has helical slots to permit expansion, the expansion being limited by the casting in of four steel bands. No greater

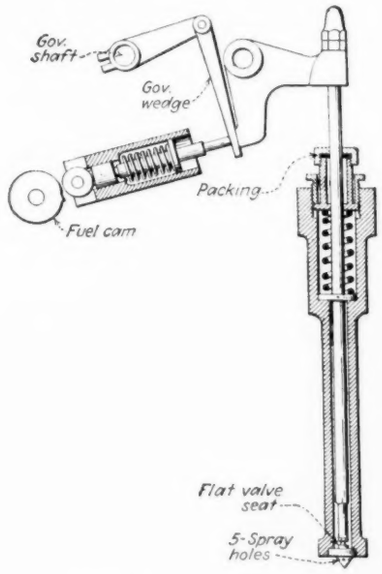

Fig. 3—Diagrammatical layout of the fuel valve

clearance is given the piston than usual, this being 0.025 in. at the rings. The upper part of the piston is tapered, and the skirt is given a slight chamfer.

No water cooling of the piston is used, as experience with this diameter piston indicates that the air cooling is

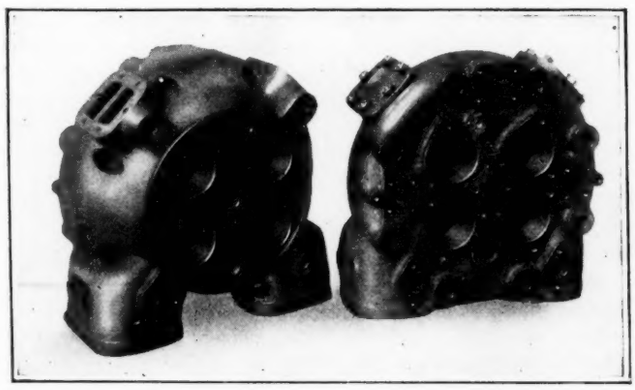

Fig. 4—Cylinder heads showing dual valve openings

satisfactory and avoids the complication of cooling water tubes and joints.

The connecting rods are of forged steel, machined all over. The steel bearing shells both for the wristpin and for the crankpin carry centrifugally cast babbitt linings. Inspection shows that these linings are unusually good; the metal is uniform in thickness and shows no blowholes.

The piston pins, crankpins and main bearings are lubricated by pressure feed. The oil is cooled in a water-cooled cooler, and the piping is so connected to the governor mechanism that if the oil pressure drops to a predetermined low value, the engines will stop.

No air compressor is included in the engine design, as it is the intention to use a motor-driven compressor. This reduces the fore and aft dimensions of the engines, an important point in yacht engineering.

In the test run the first of these two engines showed a fuel consumption of practically 0.41 lb. per brake

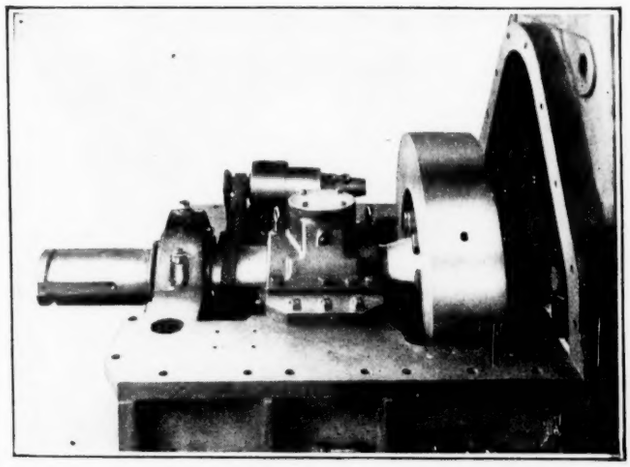

Fig. 5—The overspeed governor and thrust bearing

horsepower, and this was approached at three-quarters load. While the engines were designed for a maximum of 350 r.p.m., it is expected that 300 to 325 r.p.m. will seldom be exceeded in service.

How To Figure Diesel Plant Initial Costs

By Edgar J. Kates*

INFORMATION on the initial cost of a proposed private plant is essential to a comparison of power costs. The running expenses of a modern oil-engine plant are generally quite low, and since the reliability is assured, the question to be answered is, "How many years will it take for the private plant to pay for itself?"

The exhibition, in Table I, of detailed figures on the cost of a 1,000-kw. oil-engine generating plant for industrial use may therefore serve a useful purpose. The plant contains two units of 500-kw. capacity each, with direct-connected generators and exciters. Being located where there is not an ample supply of soft water, an inclosed cooling system has been provided for the engine-jacket water, including a 15,000-gallon tank for gravity supply and duplicate circulating pumps. Equipment is installed for reclaiming the crankcase lubricating oil. The

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air-starting tanks are normally pumped up by a motor-driven compressor, but in case of emergency a gasoline-engine-driven compressor will be used. The figures cover the cost of a complete power plant, installed and ready to run.

It is instructive to compare these figures with the cost of a 1,000-kw. Diesel electric central station as recently published in a technical report of the National Electric Light Association. This is quoted in Table II. As in the first case, the plant consists of two 500-kw. units.

It will be noted that the central station plant cost was $234 per kilowatt of capacity, while the private plant investment was only $146. The figures are not, however, as far apart as they seem, as a study of some of the larger items will show. In the central station the engines themselves cost $15 per kilowatt more than for the private plant, no doubt because the public-utility plant was built in 1923, since which time the prices of oil engines have been much reduced. The freight and handling charge in the central station reached the huge proportions of $15,600, or about $55 a ton. Such an extraordinary cost must have been due to a most unusual plant location, and the cost of approximately $3,600 or $13 a ton shown for the private plant is much closer to normal.

The building for the central station cost about $10,000 more than the other, presumably because public utilities commonly spend considerably more on their buildings than private owners.

TABLE I—INITIAL COST OF 1,000-KW. DIESEL GENERATING PLANT FOR INDUSTRIAL USE

750-hp. 4-cylinder oil engines, 2	$82,500
625-kva. 3-phase, 60-cycle, 440-volt alternators with direct-connected exciters, 2	11,688
Seven-panel switchboard, containing 2 generating panels and 5 distributing panels, also voltage regulator, cables and conduit	4,500
Motor-driven compressor for charging air-starting tanks	380
Gasoline-engine-driven compressor for charging air-starting tanks	300
Motor-driven centrifugal pumps, four 3-in.	1,512
Jacket-water storage tank, 15,000 gal	450
Steel tower for same, 40-ft.	497
Heat exchanger coils for inclosed cooling system	2,260
Headers, valves, etc., for same	1,400
Lubricating oil reclaimer, complete with heater and storage tank	370
Piping, complete	1,860
Diamond-grid floor plates	150
Underground fuel storage tanks, two 15,000-gal.	1,200
Foundations, 325-cu.yd.	3,900
Concrete soft water hotwell and raw water basin, 48 cu.yd.	720
Freight, 556,445 lb.	2,782
Unloading and placing on foundations	834
Erection, complete	5,520
Land and building, including crane	18,000
Miscellaneous	1,750
Engineering	3,500
Total cost	$146,073
Cost per kilowatt	$146

Into the cost of the central station is charged $9,400 for "interest during construction," and about $34,000 as general overhead, consisting of organization, accounting, management, legal, taxes, material overhead, labor overhead and the like. Such charges are usually considered by Public Service Commissions as items of plant investment upon which the central station is allowed to earn a fair return. Nevertheless, these expenditures are practically non-existent in the case of a private power plant. For example, an industrial concern installing its own plant has little, if any, interest to pay during construction, for the simple reason that most of the payments become due only after the plant is finished.

There are other items of extra cost of the public utility plant, but the important ones just discussed total about $80 per kilowatt of capacity. The National Electric Light Association figures therefore closely check the industrial Diesel generating plant cost of $146 per kilowatt.

TABLE II—INITIAL COST OF 1,000-KW. DIESEL ELECTRIC CENTRAL STATION IN DOLLARS PER KILOWATT CAPACITY

No.	Item	
1.	Total plant capacity, kw.	1,000
2.	Date of installation	1923
3.	Engines complete	$97.50
4.	Generators and exciters complete	11.00
5.	Cranes	2.20
6.	Clutches, reduction gears, special drives, etc.	None
7.	Switchboard and wiring	5.00
8.	Auxiliary power units, air compressors, etc.	None
9.	Water pumps; water cooling and softening equipment	0.70
10.	Lubricating oil separators, purifiers, filters	0.50
11.	Fuel-oil pumping and clarifying equipment	0.20
12.	Piping complete	6.00
13.	Shop equipment and tools	0.20
14.	Freight and handling, all materials	15.60
15.	Miscellaneous materials	.....
16.	Total machinery and equipment costs	138.90
17.	Land and titles	No data
18.	Building railroad sidings, etc.	30.00
19.	Foundations, including muffler pits, pipe trenches, etc.	10.00
20.	Lubricating oil storage	None
21.	Fuel-oil storage	1.20
22.	Superintendence	2.00
23.	Installation labor (not included above)	5.00
24.	Interest during construction	9.40
25.	Insurance (compensation)	Incl. in item 24
26.	Accounting stores, overhead	Incl. in item 25
27.	Engineering overhead	3.70
28.	Other overhead	.....
29.	Total installation cost as reported	$200.20
30.	Total installation cost allowing 25 per cent overhead on specific charges	$234.00

Freeing Carbonized Piston Rings

By A. H. Gill

CARBONIZED or gummed piston rings are met with in many oil- and gas-engine plants. Just what is the best method of freeing these rings is a matter of doubt.

An article appeared in the March 15 issue of *Power* recommending that the rings be treated with a strong solution of lye. Others believe this may cause the rings to become brittle, like the caustic embrittlement of boiler plates. While lye may do the work, in the writer's opinion it is unsatisfactory for several reasons. Hot lye is a dangerous substance to use and does not work as well as a solvent, and may cause the rings to break.

In the course of operation of the engine the oil is not wholly consumed, but, like the lubricating oil in a gasoline engine, carbonizes; that is, forms tar, which cements some of the soot or carbon formed by imperfect combustion into hard masses. To get rid of this, the automobilist uses one of several "carbon removers," some of which contain carbon bisulphide, acetone or kerosene.

Could not the same practice be followed with Diesel engines as with automobiles? It is possible to introduce the solvent into a cylinder when the engine is shut down.

Carbon bisulphide and acetone are expensive, so a cheaper substitute can be used in the shape of commercial benzol, toluol or xylol. These sell at about 35c. a gallon by the barrel. These chemicals will dissolve the tar and free the ring. These are inflammable liquids, much like turpentine in character. In place of these a heavy kerosene from asphaltic-base petroleum would be excellent.

Sizing of Coal and Its Relation to Ashpit Loss

By G. B. MULLOY

Mechanical Engineer, Motive Power Department, Armour & Company

TO ELIMINATE many of the existing heat losses in the burning of coal, much attention is being given to the pulverization and to the distillation processes. In the last five years both of these methods have met with considerable success, and depending upon the cost of processing, one of them should prove eventually to be the proper way of getting out the stored-up energy in the coal.

In the meantime it is necessary to contend with the coal as mined, and while waiting final developments, there is much that can be done at comparatively little expense to improve combustion in stoker-equipped plants. In the present article Midwestern coals will be considered from the viewpoint of preparation.

PREPARING the coal at the plant to the size that best suits the stoker in use, not only improves the combustion but also makes possible the use of a wider range of coals.

As seasonal demand governs to a great extent the size of coal offered, the buyer is not in position to take advantage of a good coal market unless his plant is equipped with the proper facilities for handling and preparing the coal as received from the mines. Through lack of these facilities many small plants today are in no position to purchase fuel economically. Often a good coal that could be obtained locally and bearing a low freight rate cannot be used by one of these plants, owing to their own equipment or the lack of facilities at the mines to supply the proper size of coal at all times. As the plant owner is primarily interested in keeping down to a minimum his fuel cost per 1,000 lb. of steam generated, he should be in position to prepare the coal to the proper size regardless of the season of the year. It should not be necessary to pay a premium of from 50c. to $1 a ton to procure a coal best suited to the particular plant needs.

Obviously, it is not reasonable to expect the mines to install equipment capable of meeting the requirements of every plant owner, as this would add more burden to the industry and be a reason for increasing the mine costs. Besides, it is not right to rate the burning qualities of a coal because of its size.

In burning coal one of the most important single items of controllable loss is the carbon in the ash. This alone may entail a loss ranging from $2\frac{1}{2}$ to 8 per cent, and it is closely related to the loss caused by excess air. To keep the one down at the expense of the other is like robbing Peter to pay Paul. Large coal supplied to the grate ignites slowly and for a given stoker speed on chain grates will drop into the ashpit high in carbon, while the finely sized coal that stays on the grate will be burned out more completely.

Coal that is too fine will fall through the grates in varying amounts, dependent upon the amount of rocking motion, or by burning out in spots, allow excess air to get through in excessive quantities. Slagging difficulties arise with coals containing excessive fines, particularly if they are high in sulphur and the ash has a low fusing point. These troubles are augmented if the operating temperatures of the furnace are so high as to permit little slice-bar agitation.

To obtain good economy coal should be of uniform size as delivered to the grate. Close contact with the daily operation of boiler rooms and the purchase of coal brings out emphatically the need of a good coal crusher. In the public utility plants this question has been receiving considerable attention, but in the average moderate-sized industrial plant the preparation of the coal has been more or less haphazard. Upon close examination of these plants it will be found that operating efficiencies may be increased $2\frac{1}{2}$ to 8 per cent, and in the larger, more modern types of plant, the over-all efficiency may be raised at least 3 per cent by the reduction of the ashpit and excess-air losses through the installation of a proper coal crusher.

Proper crushing of coal is therefore important in any program toward improving boiler-room operation. Experience has shown that, incidentally, it is responsible for reducing the labor turnover when trying to develop a grade of fireman who can handle the fires to meet sudden demands for steam while holding the proper air supply for the amount of coal burned.

Our recent experience during the coal strike strongly brings out the necessity of a good crusher, and charts taken from recording CO_2 instruments as well as the analyses of the ashpit losses offer the best evidence of how the excess-air loss increases when large lump coal is received and sent to the grates in sizes varying from $\frac{1}{2}$ to $2\frac{1}{2}$ in.

At the Chicago plant we have two boiler rooms, each built from the same set of blueprints, so that the stack capacities, boilers, stokers, arches, furnaces, etc., are exactly the same in every respect, the only exception being in the case of the crushers. During the strike we received coal that varied in size from $1\frac{1}{4}$-in. screenings to large pieces that had to be broken with a maul before going

to the crusher. With this range in size and owing to the condition and type of one of these crushers, we were not in position to deliver the proper size of coal to the boilers in one of the plants. It was found that the ashpit loss in that house ran continually higher than in the plant to which coal was being delivered to the grates uniformly sized.

With the ring hammer crusher of the pulverizer type used in the plant last mentioned, it was found that, regardless of the initial size of the coal sent to this machine, the fuel was discharged more uniform in size. Having this uniformity, we were able to set the height of the feed gate governing the thickness of the fire and hold these conditions until it was found necessary to change them for an entirely different grade of fuel. Under these conditions we are able to regulate the draft to carry the correct amount of air and maintain a remarkably high and uniform CO_2.

The difference in performance may be seen by comparing Figs. 1 and 2, the former showing the irregularity of the CO_2 when the fuel was not properly prepared and the latter the excellent results obtaining from uniform sizing of the coal. These conditions are maintained under a load that fluctuates from 150 to 205 per cent. Having a uniform grade of coal continuously supplied to the grate, our regulation consists of changing either the damper or the stoker speed as the load demands. These two controls are at the front of the furnace, at which point is installed also the CO_2 recorder and uptake recording thermometer.

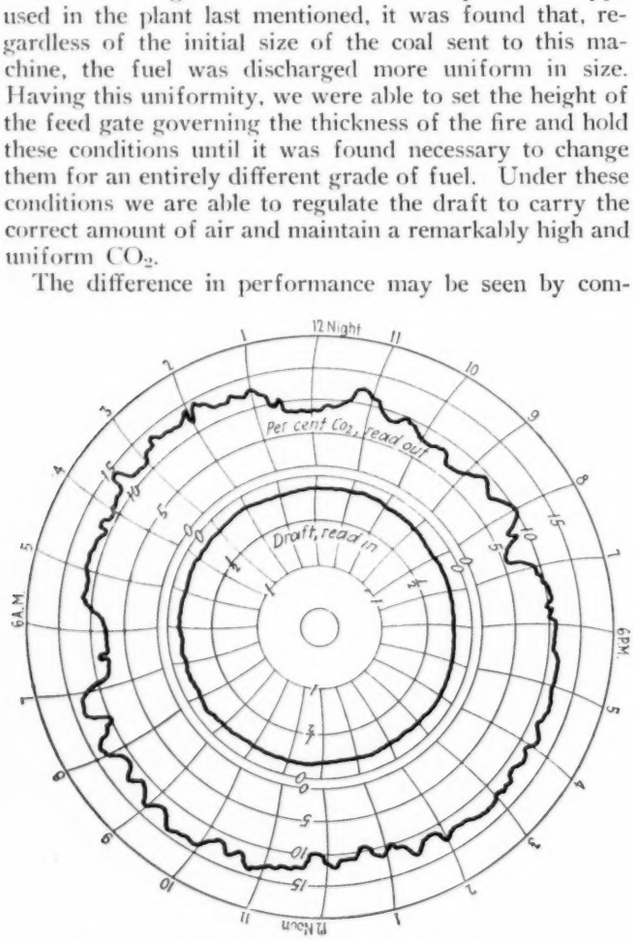

Fig. 1—CO_2 record with coal that has been poorly prepared

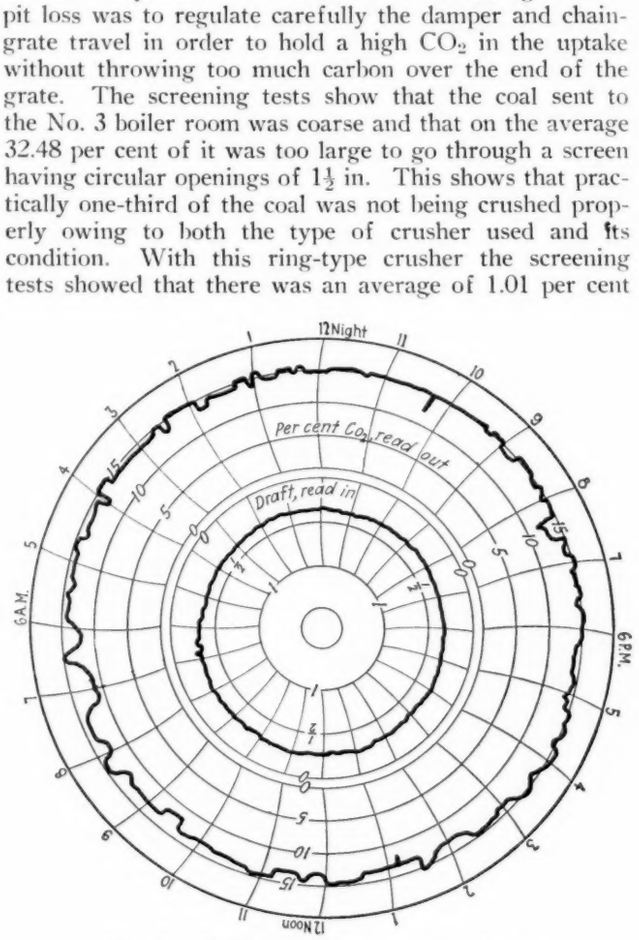

Fig. 2—Uniform CO_2 as result of using coal properly sized

Tables I and II show the results of crushing and burning a mixture of various sizes of Southern Illinois coal. The mixture consisted of 47 per cent of 6-in. lump, 42 per cent of 6- to 3-in. egg and 11 per cent of 3- to 2-in. nut. Table I shows the results of screening after crushing, with the two types of crusher previously referred to, tests No. 1 and 2 being conducted with the ring-type crusher and tests No. 3 and 4 with a multiple-roll crusher in poor condition. Table II gives all data observed on the burning tests.

The object of these tests was to compare the effect of coal preparation on the ashpit loss. In order that the results might be comparable, it was necessary to hold all other factors such as rating developed, fuel burned per hour per square foot of grate, stack losses, etc., as nearly the same as possible. Our method of controlling the ashpit loss was to regulate carefully the damper and chain-grate travel in order to hold a high CO_2 in the uptake without throwing too much carbon over the end of the grate. The screening tests show that the coal sent to the No. 3 boiler room was coarse and that on the average 32.48 per cent of it was too large to go through a screen having circular openings of $1\frac{1}{2}$ in. This shows that practically one-third of the coal was not being crushed properly owing to both the type of crusher used and its condition. With this ring-type crusher the screening tests showed that there was an average of 1.01 per cent of the original coal retained on the $1\frac{1}{2}$-in. opening screen.

In crushing coal it is also necessary to govern the percentage of "fines" to an amount best suited to a particular installation of stoker, boiler and draft available. By "fines" is meant the percentage of the original coal that goes through a smaller screen of $\frac{1}{4}$-in. diameter. Here again the tests show that for the poorly prepared coal, taking the last value in the last column of Table I, the "fines" amounted in tests Nos. 1 and 2 to 36.14 per cent for the well prepared coal, but in the other case the fines amounted to only 13.86 per cent.

There are, therefore, two limits to work for in crushing coal, one being the proper percentage of coarse coal which is the upper limit, and should be for best results according to our experience between 1 and 5 per cent; while the lower limit of the fines should range from 35 to 50 per cent. It appears that these ratios give the proper intermediate sizing of the coal to insure uniform air distribution through the bed, even burning for the full

length of the grate. Under such conditions high CO_2 can be maintained and the ashpit loss held down to a minimum under any ordinary fluctuation of load, as from 140 to 200 per cent rating.

TABLE I—RESULTS OF CRUSHING TESTS AS DETERMINED BY SUBSEQUENT SCREENING

Ring-Type Crusher

	Test No. 1			Test No. 2			Tests 1 and 2		
	In.	Lb. Oz.	Per Cent	Lb. Oz.	Per Cent		Lb. Oz.	Per Cent	
Over...	1½	0—12	1.12	0— 9	0.90		1— 5	1.01	
Over...	1¼	1— 6	2.06	1— 8	2.39		2—14	2.22	
Over...	1	6— 1	9.08	3—13	6.06		9—14	7.62	
Over...	¾	8—14	13.30	7— 4	11.54		16— 2	12.45	
Over...	½	12— 2	18.16	11—11	18.60		23—13	18.38	
Over...	⅜	7— 7	11.14	6— 5	10.05		13—12	10.61	
Over...	¼	6—14	10.30	8— 2	12.94		15— 0	11.57	
Under..	¼	23— 4	34.84	23— 9	37.52		46—13	36.14	
Total wt...		66.75 lb.	100.00	62.82	100.00		129.57	100.00	

Multiple-Roll in Poor Condition

	Test No. 3			Test No. 4			Tests 3 and 4		
	In.	Lb. Oz.	Per Cent	Lb. Oz.	Per Cent		Lb. Oz.	Per Cent	
Over...	1½	21—10	32.09	22— 9	32.81		44— 3	32.48	
Over...	1¼	9— 2	13.54	8—15	13.00		18— 1	13.26	
Over...	1	6— 4	9.28	6—14	10.00		13— 2	9.60	
Over...	¾	6— 3	9.18	5—12	8.36		11—15	8.78	
Over...	½	7— 0	10.39	6— 7	9.37		13— 7	9.88	
Over...	⅜	4— 6	6.49	4— 3	6.09		8— 9	6.30	
Over...	¼	4— 1	6.04	3—14	5.64		7—15	5.84	
Under..	¼	8—12	12.99	10— 2	14.73		18—14	13.86	
Total wt....		67.125 lb.	100.00	68.75	100.00		136	100.00	

Note: Samples of coal were taken from the conveyor as it traveled across the top of the coal bunker, from every tenth bucket in the dry state, during the process of unloading two 50-ton cars for each type of crusher. The fuel being handled was from the Galesburg storage pile and consisted of Christopher and Frankfort Mine Coals. As stored on the pile the coal was 6-in. lump, egg and nut sizes. Screens used for screening tests had the circular type opening. Tests conducted by G. B. Mulloy, T. Harrington and J. Black.

TABLE II—COMPARATIVE TESTS IN BOILER HOUSES NOS. 2 AND 3 TO SHOW EFFECT OF COAL PREPARATION

Boiler House	No. 2				No. 3			
Test Number	1	2	3	4	5	6	7	8
Boiler rating, dev., per cent	168.8	158.4	196.4	183.9	159.6	169	159.5	165
Grate surface, sq.ft.	105	105	105	105	105	105	105	105
Coal burned on grate, lb.	27610	29475	29240	31670	28415	32330	27570	30410
Coal burned per hour, lb.	3451	3468	3655	3960	3552	3805	3445	3801
Coal burned per hr. per sq.ft. of grate, lb.	32.9	34.1	34.8	37.7	33.9	37.4	32.8	36.2
Total weight ashes, lb.	3521	3200	3305	3420	3910	4900	4700	4920
Refuse and ashes, per cent	12.75	10.86	11.30	10.80	13.76	15.16	17.05	16.18
B.t.u. refuse	3000	2850	2275	2725	3200	2875	4020	4375
B.t.u. coal as fired	11050	10525	11860	10690	10400	10225	10775	10675
Total stack losses, per cent	19.9	20.78	18.25	20.56	19.74	19.41	20.97	22.27
Ashpit loss, per cent	3.46	2.94	2.17	2.75	4.23	4.26	6.36	6.63
Total losses, per cent	26.06	27.37	24.14	27.26	27.72	27.20	28.04	32.00
Over-all efficiency	73.9	72.63	75.86	72.74	72.28	72.8	71.96	68.0
Flue gas temp., deg. F.	622	616	615	632	590	595	594	617
CO_2 maintained at damper	13.50	13.34	13.90	13.60	12.84	12.69	12.00	11.42

Note: Flue-gas temperature recorders were checked for accuracy during test. Boiler No. 7 in boiler house No. 2 had been on line since May 30 and No. 7 boiler in No. 3 boiler room since June 6. During this period boiler house No. 2 carried 10 per cent heavier load than No. 3 house, as an average on all boilers. Variation in B.t.u. value due to foreign matter mixed with original coal during process of loading from storage pile, also due to amount of water used in wetting down coal just previous to burning.

In Manufacturing Plants Handling Heavy Material by cranes or hoists, the load is usually lifted on a chain or wire-rope sling, having an enlarged link or ring which is placed over the crane or hoist hook. As this ring bears the whole load, it must be of ample strength, and because of its large diameter it requires a larger cross-section than the rest of the sling. It is customary to make such rings of refined bar iron on account of its welding properties and because it will bend to a noticeable extent before breaking. A type of ring said to be more dependable, as there is no cross-weld, consists of a bundle of wires knitted together. Such a ring (patent applied for by the Baldwin Locomotive Works) is made by winding many turns of wire on a spool to form a blank of proper size. The blank is then thoroughly heated and is formed between dies under a powerful hammer or press. This forming operation causes the wire to fill the voids between the turns, and it will not unwind under strain. The original article shows specimens which have been tested to destruction.—*Baldwin Locomotives*, Vol. 6, No. 1.

What Do You Know?

By L. H. Morrison

The answers are on page 709

THE head of the great mail order house of Sears, Roebuck & Co. has upset tradition by declaring his success to be due to luck. However, he might have further declared that opportunity, when knocking at his door, always found him in a receptive mood and prepared to do the job offered. Are you all dressed up ready to trot along when the knock is heard? Do you know enough of engineering to handle the job when luck appears? Try answering these ten questions as a part of a self-examination.

Ques. 1—What is a herringbone grate and why is it so named?

Ques. 2—What else besides the uniflow engine did Jacob Perkins invent?

Ques. 3—Was there ever a uniflow built in the United States in which steam was taken at the center and exhausted at the ends?

Ques. 4—What engine built in this country first used poppet valves?

Ques. 5—At any given instant which is moving the faster, in a horizontal direction, the center of the locomotive drive wheel or a point at the top of the wheel diametrically opposite the point where the wheel contacts with the rail?

Ques. 6—What is the advantage in a brick lining for a steel stack?

Ques. 7—Where is the lime process of boiler feed water treatment used?

Ques. 8—If a steam engine is to be operated with air, what alterations, if any, are necessary to be made in the cylinder, the air compressor to be the same as the steam pressure?

Ques. 9—What kind of valves are used on the Putnam steam engine?

Ques. 10—Who was William John MacQ. Rankine?

ELECTRICAL *Operation and Maintenance*

New Types of Squirrel Cage Motors

By R. H. BACON

Development Engineer, Fairbanks, Morse and Company

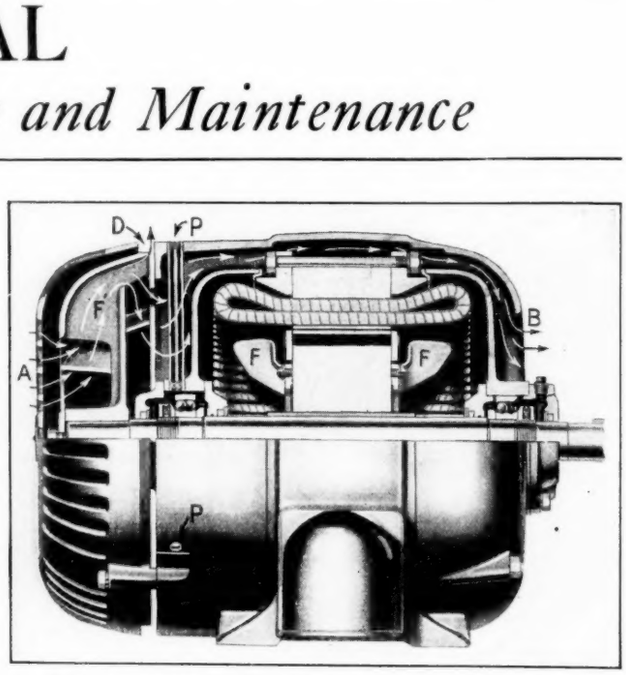

Fig. 1—Section through a self-ventilated totally inclosed type motor

ELECTRIC motors have reached a high degree of refinement and their general dependability is such that the average user is likely to overlook the constant development going on in this equipment. There have been many improvements made in electric motors during the last few years. These have been concerned mainly with the problems of adapting motors for specific applications and to reduce the necessity for frequent inspection.

Although the standard open-frame squirrel-cage motor meets most of the requirements for ordinary service, it has certain disadvantages that become rather serious in many applications. It has been found, for instance, that a standard open-frame motor operated in places where there is considerable dust in the air, will soon have its ventilating ducts clogged, resulting eventually in overheating unless the motor is frequently cleaned. An even more serious condition exists in cases where the air contains metallic dust, particularly iron, because this dust works into the winding and may in time cause a breakdown of the insulation.

There has been a demand for an inclosed type of motor to meet these particular operating conditions, and there have been a number of developments in inclosed motors in the attempt to solve this problem. The totally inclosed motor has been used in such service, but, as such a motor has no means of ventilation, it must be made considerably larger than a standard machine of the same horsepower output. The result is high first cost per horsepower, decreased power factor and poor efficiency. The sizes in which the totally inclosed motor may be built are therefore limited and the cost per horsepower is always considerably higher than is that of a standard motor.

Another development in inclosed motors has been the use of air piping for conducting clean air to the motor with a fan built into the rotor for providing the necessary flow of air. The disadvantage of this type of motor is due mainly to the necessity for providing the air pipes. This not only adds to the expense of the installation, but it may be difficult to reach a source of clean air within practical distances from the motor and may require elaborate systems of air ducts.

One answer to the inclosed motor problem appears to lie in the recent development of inclosed self-ventilated types in which the windings are entirely protected from the air currents. There have been several developments along this line, one of which is that recent announcement by Fairbanks, Morse & Company of a line of self-ventilated inclosed motors which also have an interesting air-cleaning feature. The sectional view, Fig. 1, of one of these motors clearly shows the construction.

This motor has a standard stator core and windings and a standard rotor mounted in a supporting shell with an annular air passage between the outside surface of the stator core and the shell. Winding shields are provided so that the stator windings are totally inclosed, thereby preventing any dirt from gaining access to these windings. Cooling air is drawn through an inlet opening at *A*, in the free end of the motor, by means of a special type fan *F'*, which also functions as an air cleaner. The clean air is blown across the winding shield at the free end of the motor, through the annular air space, then across the outer end of the stator core laminations, across the winding shield at the pulley end and out through openings at *B*. The flow of the air through the motor is shown by the arrows.

The fan *F'* is of the closed impeller type and is so constructed that the foreign particles are thrown out by centrifugal force, between the edge of the outer shroud and the supporting frame, at *D*. A perforated guard is placed around this fan cleaner and is carried by the sup-

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porting frame. The purpose of the guard is to prevent accidental contact with the fan, the fan itself being an entirely self-contained air cleaner and blower.

Provision is made for lubricating the ball bearings of this motor without removing the guard, fan or bearing arms. This is accomplished by the use of a plunger device *P*, located in a grease tube extending through an opening in the bearing arm into the bearing housing.

This type of motor has the advantages of being completely self-ventilated and cleans its own cooling air by means of a built-in automatic air cleaner; it is impervious to dust and dirt in the air; it is built in the same frame diameter as standard motors of corresponding horsepower; no air piping is required; it will operate in the dustiest locations without requiring blowing out; the fire hazard is reduced, as the windings are totally inclosed and the air for ventilation does not come in contact with them; and it requires no more attention than a standard ball-bearing motor.

Motors for Severe Service

There are many fields of service such as flour mills, sawmills, rock quarries, machine shops, chemical plants, cement mills, ice plants and similar service where motors must be protected from dust, sawdust, metallic particles or corrosive liquids and fumes. The demand for a simple inclosed self-ventilated type of motor which will

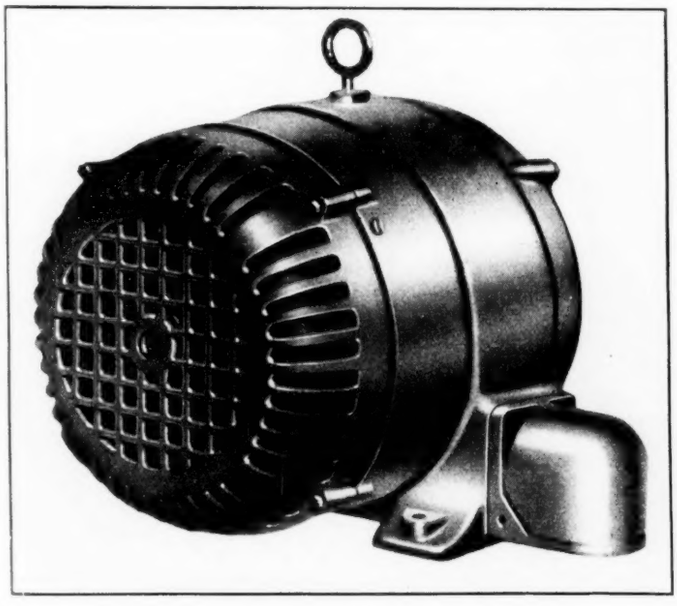

Fig. 2—Complete assembly of totally-inclosed self-ventilated motor

give this protection has been considerable, and the recent developments in motors of this type will solve one of the difficult motor-application problems.

The simplicity of the squirrel-cage motor has resulted in a widespread adoption of this type of machine in all applications where speed variation is not required and where alternating current is available. The one main disadvantage of the squirrel-cage motor has been its high starting current. In small motors the high starting current is not objectionable, for most power companies will permit the installation of motors up to five horsepower without requiring the use of some type of starting compensator. With larger motors, however, it is frequently

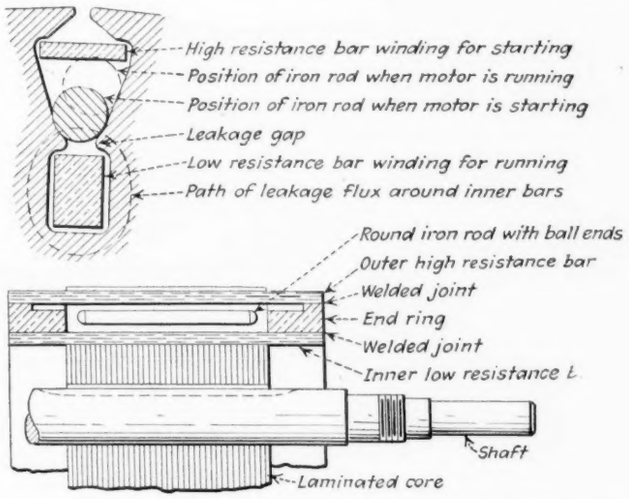
High resistance bar winding for starting
Position of iron rod when motor is running
Position of iron rod when motor is starting
Leakage gap
Low resistance bar winding for running
Path of leakage flux around inner bars
Round iron rod with ball ends
Outer high resistance bar
Welded joint
End ring
Welded joint
Inner low resistance b
Shaft
Laminated core

Fig. 3—Sections through one rotor slot of an improved type of double-squirrel-cage motor

necessary to use some type of starter that will reduce the voltage and thus limit the current during the starting period. On types of service requiring a high starting torque, such as those having considerable inertia or static friction, the starting currents are still greater, and if starters of the reduced-voltage type are used, the starting torque of the motor is considerably reduced.

Double-Squirrel-Cage Winding

In the design of squirrel-cage motors it is possible to use high-resistance rotor bars in order to get a high starting torque with low starting current, but such a motor has comparatively low efficiency and poor power factor at full load and normal speed. If the motor is designed with low-resistance bars in the rotor, then the starting torque is reduced and the starting current is increased, although the motor has better operating characteristics at normal loads and speed.

During the last few years one of the motor developments has been what is known as the double-squirrel-cage type. In this motor two sets of bars are placed in the rotor, each set being connected with its own end rings. The low-resistance bars in this case are placed in comparatively deep slots in the rotor and the high-resistance bars in comparatively shallow slots. The inner low-resistance winding in the rotor core chokes the current in this winding at starting and forces it to flow in the outer high-resistance winding, thereby producing high starting torque with comparatively low starting current. After the motor has accelerated and is carrying normal load, the low-resistance winding carries the greater portion of the current. Owing to this winding's

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position in the rotor core, the power factor and maximum torque are less than with a standard or single-squirrel-cage winding.

The advantages of the double-squirrel-cage motor are its ability to be connected directly to the line without using a compensator or starter to reduce the starting current; it has ample torque to start and accelerate loads having considerable inertia or static friction; and it simplifies the control of the motor by using an ordinary starting switch or by using a magnetic contactor with push-button control.

The principal disadvantages of the double-squirrel-cage motor are its low maximum running torque and poor running performance as compared with the single-squirrel-cage motor. The low maximum output is objectionable because momentary overloading together with

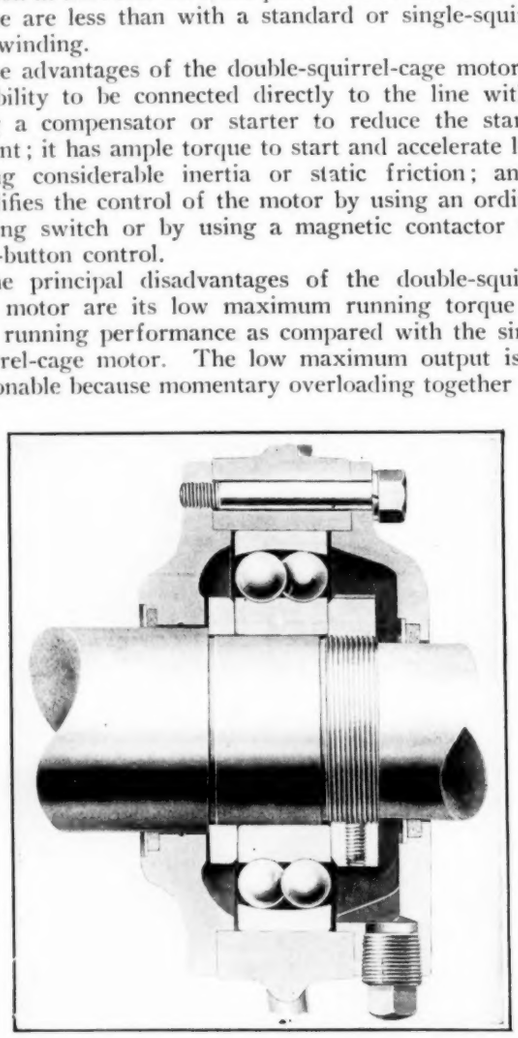


Fig. 4—Section through a ball bearing applied to electric motors

reduced line voltage may result in the motor's stopping. The running performance is affected principally by reduced power factor and efficiency. The low efficiency increases the power cost of operating the motor, and the low power factor is objectionable to the power company or industrial power plant.

Improved Type of Motor

A recent development in a double-squirrel-cage motor is that of Fairbanks, Morse & Company in a motor called a variable-leakage double-squirrel-cage type. Fig. 3 shows a section through the rotor slots, which gives an idea of the construction. In this motor the current in the inner winding at starting is choked by means of movable iron rods. These rods are placed in each rotor slot between the inner and outer bars. The instant the motor is connected to the line, the iron rods are pulled down toward the inner bars, closing the leakage gap in the rotor iron, as shown in the figure. This results in an almost complete choking of the current in the inner low-resistance winding by forming a complete iron circuit around each bar of this winding. This choking action on the inner winding forces practically all the current to flow in the outer high-resistance winding at starting, thus producing a high starting torque with a low starting current.

As the rotor accelerates, the iron rods are thrown out of the leakage gaps by centrifugal force, to the position indicated by the dotted circle in Fig. 3. This removes the choking effects from the inner winding when the motor is running and results in a better running performance than with the older style of double-squirrel-cage motor. It is also possible to use much higher resistance in the outer winding where low starting current is desired and where the starting torque requirements are moderate.

At starting there is a slight noise due to the rods' changing position, but since this change is practically instantaneous, the noise is not objectionable.

Anti-Friction Bearings

Another refinement in the construction of electric motors has been in connection with bearings. The use of ball and roller bearings has made rapid progress because these types of bearing have shown many practical advantages as compared with the use of old-type sleeve bearings.

Statistics have shown that more than 40 per cent of motor repairs are made necessary by the breakdown of windings that have become oil soaked. With the old-type sleeve bearings it has been found almost impossible to keep the oil from traveling along the shaft and thus getting into the winding.

An important advantage of ball-bearing motors arises from the manner in which they are lubricated. Grease is used rather than oil. Grease lubrication in combination with tightly sealed bearing housings makes the motor free from oil leakage, dripping or spattering. Grease lubrication likewise prevents oil from spattering outside of the motor. Ball-bearing motors are usually provided with sufficient grease in the bearing housings to lubricate the bearings for a year of ordinary service.

Ball bearings are not affected by ordinary belt or chain tension or gear pressure as contrasted with sleeve bearings, which depend for lubrication on a film of oil between the shaft and the bearing, which on suddenly applied or excessive loads may be broken so that metal comes in contact with metal, causing destructive bearing wear and frequent replacements.

There is no appreciable wear on anti-friction bearings, and the highest possible mechanical efficiency is obtained. The possibility of wear from grit or dust is eliminated because these bearings permit the use of a housing that excludes all foreign material. The absence of wear keeps the rotor shaft in alignment, maintains the uniformly small air gap necessary for high efficiency and prevents the rotor from rubbing against the stator and eventually causing a burnout.

ELECTRICAL *Operation and Maintenance*

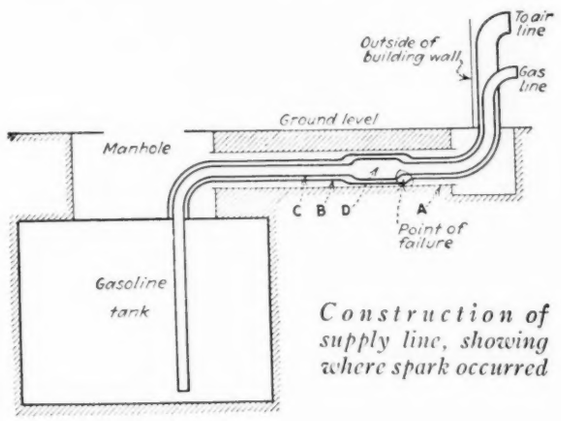
Static Electricity in Gasoline Line

By E. McCormack

AN INTERESTING and almost tragic case of a gasoline supply line interruption was recently brought to my attention. The line from a large underground gasoline tank to a near-by building had been interrupted and a possible cause was thought to be electrolytic action from cables which ran near the line. This was considered improbable, however, since the cables carried alternating current only.

Conditions were found to be as shown in the attached figure. A cast-iron casing *A* inclosed the lead pipe line from the tank-head to the building. This casing was installed to protect the pipe from settling of the ground, and opened at the ends into the building and the manhole above the tank. A lead pipe *B* formed the air line through which pressure was applied to the tank to force the gasoline out through the inner delivery pipe *C*, also of lead. This construction was considered as a safety measure, since in case of accident the air line would be broken before the supply line, thus stopping the gasoline flow.

During the investigation a section was cut out of the iron casing and showed a large hole burned in both the outer and inner lead pipes at the splice, although the iron had not been damaged. This hole was apparently burned from the outside of the supply line and from the inside of the iron casing, since the latter was intact. The fact that the lead was melted precluded any possibility of electrolysis as the cause, and the following theory was advanced. The cast-iron pipe, opening into the building, had collected a certain amount of gasoline vapor. At starting time in the morning when the gasoline was turned on, the surge through the supply line caused a static charge in the lead pipe and a spark jumped from the splice to the iron casting, igniting the vapor. The



Construction of supply line, showing where spark occurred

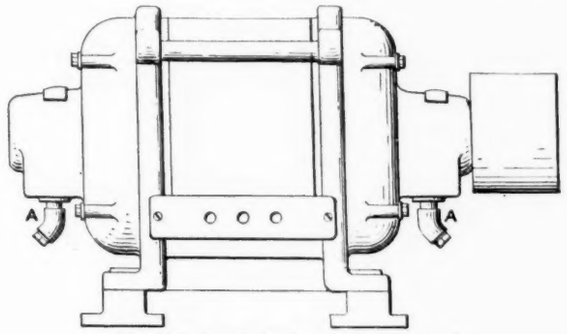
flame melted the pipes and was then extinguished because of lack of sufficient air to maintain combustion.

Subsequent investigation on the part of the manufacturer of the gasoline system showed that this was a highly probable explanation. The remedy suggested was the removal of the cast-iron casing from around the lead pipe, leaving it in contact with the earth.

Keeping Oil Off Motor Windings

By Guy W. Kay

SERIOUS damage may be done to motor windings due to oil running into the machine when being drained from the bearings. The amount of oil that gets



Modified oil drains shown at A

to the windings at any one time may be small, but eventually the insulation may be badly deteriorated.

To prevent this trouble, I removed the drain plugs from the bottom of the bearings and replaced them with a nipple and 45-deg. elbow, as shown at *A* in the figure. If desired, a short piece of pipe may be screwed into the lower end of the elbow, in the larger motors. This has worked satisfactorily and has prevented oil from working from the drain down the bearing bracket into the motor.

Motor Troubles Reduced to a Minimum by Welding Rotor Bars to End Rings

I HAVE been much interested in the numerous articles that have appeared in *Power* on motor troubles of various kinds, and in view of the large number of old-style motors that are still in use I thought some of my own experience along that line might be of interest.

For about 15 years I have had charge of a group of 25 induction motors ranging in sizes up to 30 hp., and for several years our chief trouble was loose rotor bars with consequent low speed and overheating. We cleaned and soldered and tightened the short-circuiting rings and rotor bars, but they would not stay put.

About five years ago I saw an advertisement in *Power* featuring a rotor in which the rings and bars were punched in one piece out of a solid copper sheet and bent into the rotor lamination slots. I took a hint from that advertisement and had the rotor taken out of one of our most troublesome motors and had the rings and bars oxyacetylene welded into a solid squirrel cage. That worked so well that I soon followed with all my other offenders, and since that time I have not had a single rotor failure. Nothing that we have ever done in the line of motor repair has given us so much real satisfaction. The bolts and nuts of the rings and bars were simply melted into a solid piece. R. Manly Orr.

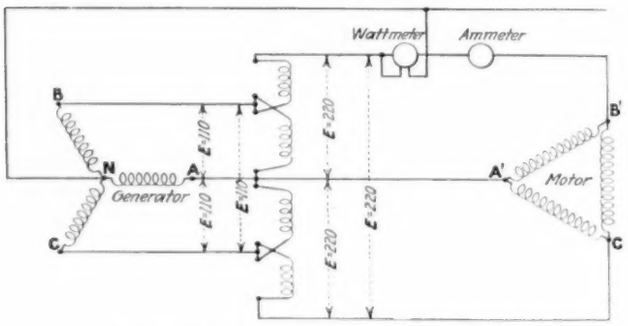
Vancouver, B. C.

ELECTRICAL *Operation and Maintenance*

Why the Wattmeter Reading Was Too High

By Elmer S. Smail

SOME years ago, in connection with a test on a squirrel-cage induction motor, I had an experience which permanently cured me of the habit of taking things for granted. The motor was a 220-volt three-phase machine, but at the time the work was to be done the only available source of power was a belt-driven star-connected 110-volt



Connection of motor to the generator

three-phase generator. Two single-phase transformers were available, and these were connected so that the low-voltage sides formed a one-to-two step-up autotransformer, thus giving the proper service for the motor, as shown in the figure. For metering we had one voltmeter, an ammeter and a single-phase wattmeter.

The voltmeter, when connected across the phases showed them to be balanced at 220 volts. The ammeter, when connected in the motor leads, showed the same current in each, indicating a balanced system just as we expected, there being no load other than the motor.

As the generator had its neutral brought out, it was decided that the true power could be most easily obtained by connecting the wattmeter's potential coil from the neutral to any one of the motor leads and connecting the current coil in series with that same lead. The theory was that the potential coil would be subjected to the star voltage, the current coil to star current and the true power would be three times the wattmeter reading. The voltmeter connected across the motor leads read star volts, the ammeter star current, and the apparent power in volt amperes would be *volts* $\times$ *amperes* $\times$ 1.732.

Soon after the motor was loaded, a preliminary check of the meter readings revealed a low efficiency and a power factor suspiciously high, which was confirmed by additional checks. The true power in watts was not only much higher than the load on the motor led us to expect, but came so near the value of the volt-amperes that adjustments had to be made to keep from exceeding it and making the power factor over 100 per cent.

When the voltmeter was connected across the neutral and the motor lead in which the wattmeter current coil was placed, the reading was 172 volts. A similar voltage was obtained from the neutral to the other outside lead, but to the middle lead only 63.5 volts showed on the meter. The expected star voltage was 57.7 per cent of 220, or 127 volts. Apparently, the neutral was not in the correct position, but in view of the fact that it came out of the generator and was so labeled, we found it difficult to doubt it. Meters, transformers, wiring, etc., all came in for general condemnation, but to no avail until someone thought of the open-delta step-up transformer connection.

The diagram shows that the generator neutral is correct for the 110-volt system, but is out of place for the 220-volt circuit, since lead *AA'* runs directly from the generator to the motor and not through the transformer. One remedy for the meter difficulty would have been to use three single-phase transformers star connected, but we obtained another wattmeter and connected the two in the usual way to meter three-phase power.

Two-Phase Compensator Used to Start Three-Phase Motor

By M. E. Wagner

RECENTLY I had the job of providing a power drive on short notice. A spare motor was located suitable for the load, but no compensator was available. The motor was three-phase rated at 25 hp., 440 volts. A two-phase compensator of the correct rating was found at a second-hand dealer's, and as this seemed to be most readily obtained, it was decided to make use of it.

The original connections were made as indicated in

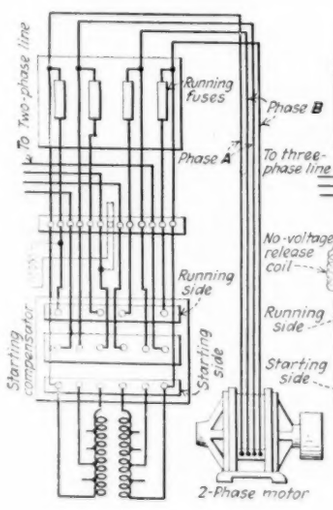


Fig. 1—Compensator connected to a two-phase motor

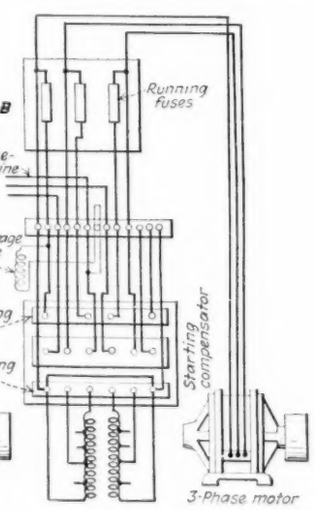


Fig. 2—Compensator connected to a three-phase motor

Fig. 1. To connect the compensator for three-phase operation the connections were changed to correspond to the diagram, Fig. 2. This compensator has served its purpose satisfactorily and has not given any trouble, and it saves considerable over the cost of a new one, which probably would have had to be obtained from the factory. This would have entailed considerable delay

Estimating the Most Economical Vacuum for Turbines*

By I. V. Robinson, Mem. A.S.M.E., M.I.M.E., and R. J. Kaula, M.I.E.E.

THE method presented for estimating the most economical vacuum for a steam turbine is based on the fact that the minimum cost is represented by the point of intersection of the curves representing the decreasing rate of cost of steam consumption and the increasing rate of cost of pumping with increasing vacuum.

In order to construct the necessary curves, the rates of variation of the various items and charges involved with the vacuum must first be determined. The charges to be considered in raising the vacuum are:

A. Total cost of condensing plant and auxiliaries.

B. Cost of turbine designed for high vacuum.

C. Increased running cost due to extra circulating water to be pumped; to the additional air pump steam or power consumption; and to the extra steam used to compensate for the reduced condensate temperature.

The savings due to an increased vacuum are:

D. The reduced capital charges consequent on the reduction in size of boiler, fuel equipment and piping.

E. The reduced running charges due to saving in steam consumption of turbine.

A typical example will be taken as the basis for illustrating the calculations involved. A 15,000-kw. turbine has a full-load steam consumption of 10 lb. per kw.-hr. when the vacuum is 29 in. The temperature of the cooling water is 55 deg. F. A range of vacuum from 28.6 to 29.1 in. will be investigated. The total head on the circulating pump is 25 ft.

A. Variation in Condenser Costs

It has been ascertained that the variation of cost of the condensing plant with decreasing temperatures is inversely proportional to the logarithm of the difference d between the vacuum temperature t_v and the circulating water temperature t_1, or the cost is

$$P_c = \frac{A}{\log d} + B$$

where A and B are constants and can be obtained by getting two quotations for condensing plants to the same specification and for different vacuums. With suitable values the rate of variation in dollars per degree F. is as shown in Fig. 1.

B. Variation in Turbine Costs

It may be stated briefly that the extra cost of turbines designed for high vacuum varies inversely as the third power of the temperature corresponding to the vacuum for which the turbine is designed, or

$$P = \frac{A}{t_v^3} + B$$

where A and B are constants and can be determined from two quotations for turbines to the same specification but for different vacuum. The rate of variation of cost P with temperature, can then be calculated and a curve plotted. Such a curve, calculated from suitable values of A and B is also shown in Fig. 1.

C. Variation in Pumping Costs

The actual cost of running the condensing plant pumps is the major item which really determines the most economical vacuum. The most power is taken by the circulating pump in our present example.

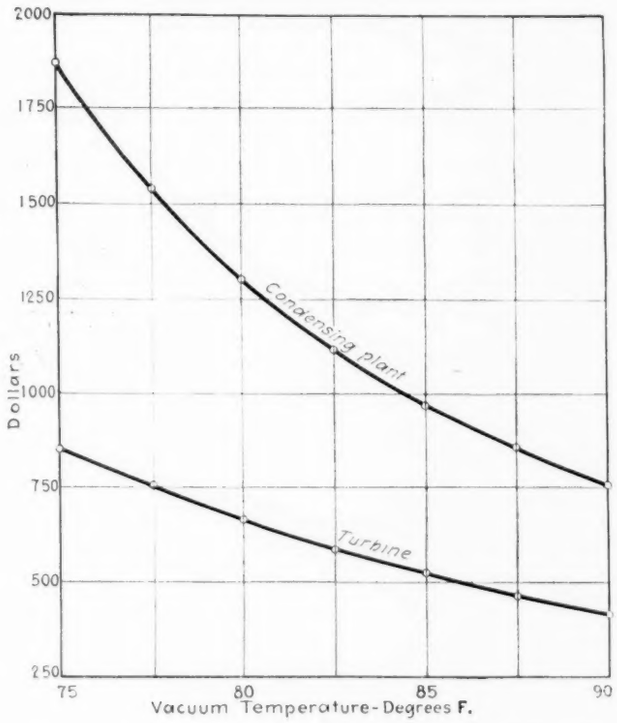


Fig. 1—Variation of costs of condensing plants and turbines with different degrees of vacuum

The total head on the pump has been taken as 25 ft. The quantity of cooling water has, for the 29-in. plant, been calculated upon a difference, d, of 11 deg. between the circulating-water discharge temperature and the vacuum temperature. For a higher vacuum this has been increased to 12 deg., and for a lower vacuum it has been decreased to 8 degrees.

The quantity of dry air to be extracted has been assumed to be constant at 50 lb. per hour, or 12 cu.ft. per min. for all degrees of vacuum. This figure is in excess of the quantity which should be present in a plant which is maintained in good condition. The steam re-

*Abstract of article appearing in *Electrical Times* (England) of March 24 and 31, 1927.

quired per hour in a two-stage steam-jet air extractor varies from 8 lb. per pound of air for a vacuum of 28.6 in. to 12.2 lb. per pound for a vacuum of 29.1 in. (These values are taken from the authors' book, "Condensing Plant," Messrs. I. Pitman & Sons. Page 133. Fig. 206.)

From such foregoing data, the cost of power for various degrees of vacuum can be calculated and a curve constructed showing the cost of power as a function of the vacuum temperature.

It is not possible to give a general equation for this curve, so that it is necessary to use the trial-and-error method of finding an equation for this curve. The differential of the equation represents the rate of increase of cost of power consumption as a function of the vacuum temperature. From the formula so determined, the rate of increase of pumping cost per degree F. for 100 per cent running hours can be obtained. Thus, in our example, for 75 deg. F. vacuum, the rate as calculated is $1,960 and varies down to $232 at 90 deg. F. At a 50 per cent hour factor the values are one-half those at 100 per cent hour factor.

The capital charges that have to be added to the pumping costs are independent of the running hours. They are determined by adding the turbine and condensing plant costs and, where required, the cooling tower rates of cost, and deducting the corresponding boiler charges. The result is to be multiplied by the percentage rate of interest and depreciation and divided by 100. In the case of our example, taking the rate of interest at 12½ per cent, we find that the rate of increase varies from $187 at 75 deg. F. to $4.80 at 90 deg. F. If these figures are added to the pumping costs, we find the total *increasing* costs. Thus in our example, we find the total costs, for a 100 per cent hour factor, vary from $2,147 at a 75 deg. F. vacuum to $227 at a 90 deg. vacuum. With a 50 per cent hour factor these costs vary from $1,167 at 75 deg. to $111 at 90 deg.

D. Variation in Cost of Boiler Plant

This item should cover the cost of the complete boiler equipment including coal and ash handling plant and can be taken as proportional to the normal turbine steam consumption. Therefore, as the steam consumption varies directly with the drop in vacuum temperature, so does the boiler plant cost and, in the case of our example, at the rate of ⅓ per cent per degree. If we take the cost at 29 in. vacuum at $365,000, then the rate of variation is $1,215 per deg. F.

E. Variation of Steam Consumption with Vacuum

Provided we are dealing with units of a size and speed and a range of vacuum for which it is practicable to build turbines of equal thermodynamic efficiency over the range of vacuum under consideration, the cost of steam is inversely proportional to the available adiabatic heat drop. It is found that, for all practicable steam conditions, the heat drop is a straight-line function of the vacuum temperature, therefore the calculation of the rate of variation with vacuum temperature is simple.

Thus, in our example it has been assumed that the total steam per hour at 29.0 in. vacuum is 150,000 lb. and with 28.6 in. the consumption will be increased to 155,250. This increase of 5,250 lb. is due to an elevation of 10.5 deg. F. of the vacuum temperature and the rate of increase is therefore 500 lb. per deg. F. per hour or ⅓ per cent of the consumption at 29 inch.

The cost of steam delivered to the turbine has been assumed to be 36c. per 1,000 lb. This figure is intended to cover all charges originating in the boiler house, such as labor, interest and other capital charges, as well as fuel. The figure of 500 lb. per deg. per hour has therefore, for a 100 per cent load factor, to be multiplied by 8,760 hours per annum and by the cost of steam. This gives a rate of variation of cost of steam of $1,585 per degree F.

A plant running on a 50 per cent load factor may be running at full load for half time or continuously at half load or under conditions between these extremes. The steam and fuel consumption, and consequently the rate of variation of cost, vary accordingly, being a minimum for the former condition. If in the case of our example,

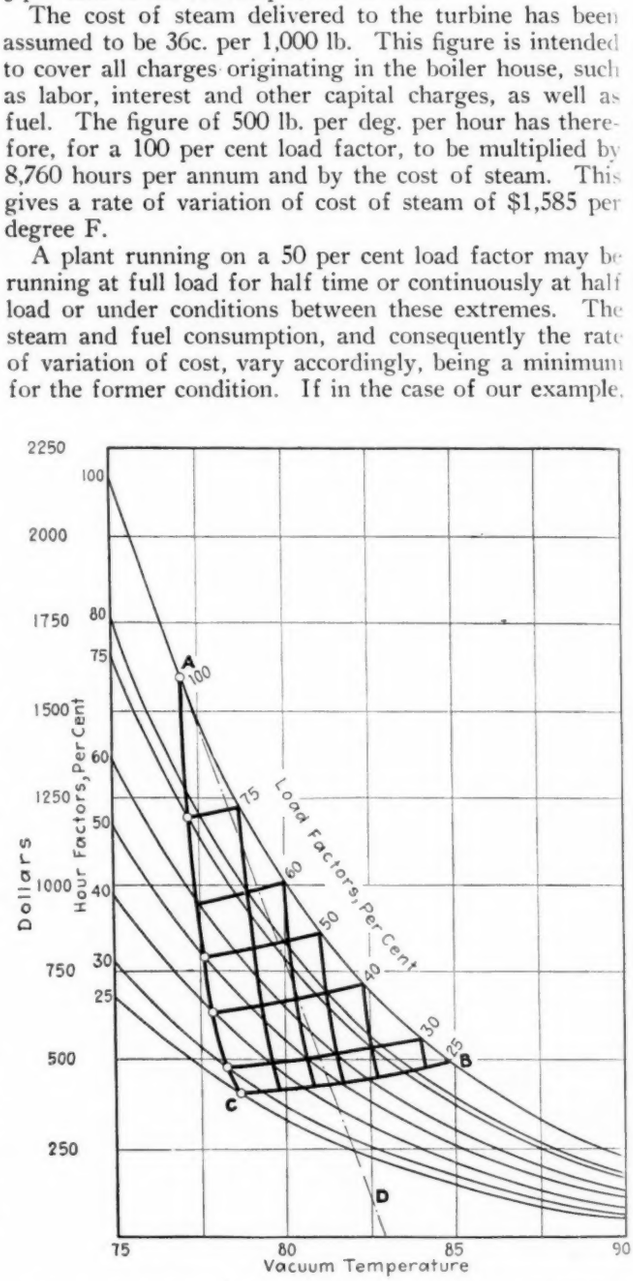


Fig. 2—Variation of total costs and degrees of vacuum under different load- and hour-factor conditions

the total hourly steam consumption is (9.2 kw. + 12,000) lb., then the rate of variation of fuel cost will vary at 25 per cent load factor from $398 to $491, and from $1,196 to $1,226 at 75 per cent load factor.

In the case of the pumping costs, assuming that no provision is made for adjusting the auxiliaries with the load, the variations are solely dependent on the percentage of running hours.

Summary

Fig. 2 shows the summarized result of the calculations. The steep curves, *A-B*, etc., represent the increasing rates of cost for various hour factors. Horizontal lines

represent the rates of saving in fuel costs for different load and hour factors. The points of intersection represent the most economical vacuum temperatures for the respective conditions.

The curves *A-C*, etc., approaching the vertical, are superimposed and represent average loads derived from the varying load factors and hour factors, but have no bearing on the problem of determining the most economical vacuum. Conditions of running at 25 per cent load factor and 100 per cent hours factor would not arise in practice, and in fact the same may be said to apply to all conditions represented by the fraction of the diagram on the right hand side of line *A-D*.

If we examine the effect of a variation in the allowance due to capital charge and assume that these rates should be twice those assumed, we shall have to plot another series of curves *A-B*, etc., and it will be found that the effect is to raise the temperature of most economical vacuum, by only 1 to 2 deg. F.

A new series of curves, *A-B*, etc., is also needed for a variation in pumping conditions, and since the pumping charge item is of greater moment, the effect of a variation is naturally more marked.

Variations in the fuel costs affect the curves *C-B*, etc. Since the steam costs and the rates of saving effected and represented by these curves are made up of a number of factors of which the cost of fuel represents one item, the actual effect of a variation in fuel cost is not so marked as might be assumed.

Cooling Boilers

THE ideal method of cooling boilers of any type, especially those with brick settings, is to close all openings to the setting and allow the boiler to stand several days after drawing the fires without emptying it. By thus giving ample time, the cooling is slow and uniform, the material contracts uniformly, and the riveted joints and tube ends accommodate themselves to the change without distress. Unfortunately, industrial conditions seldom permit of sufficient time for this ideal way of cooling, and so some modification of it must be adopted. But it should be remembered that boilers are abused when emptied immediately after having fires drawn, especially when under steam pressure. The heat of the setting is quite likely to burn the boiler, but even if this should not occur, the sudden, unequal cooling of different parts, and consequent non-uniform contraction, causes a decided shock to the structure, particularly the joints and tube ends.

When the fires have been burned out and drawn or dumped, all hot ashes should be removed from the grate, ashpit and combustion chamber. After removal of the fire the steam valve may be closed, and the boiler should then be blown down several times for the purpose of clearing the blowoff passages to avoid difficulty in emptying the boiler by gravity when cold and not under pressure. When the temperature of the boiler and setting becomes fairly low, cooling may be safely expedited by letting air pass through the gas passages.

THE CURVES REPRODUCED IN THE ABSTRACT "Capacity of Up-Feed Steam Heating Risers," appearing in the Oct. 11 issue, are copyrighted by the American Society of Heating and Ventilating Engineers and can be republished only with its permission.

Answers to What Do You Know

The questions are on page 701

Ans. 1—A herringbone grate is made up of two horizontal side bars connected by a series of V cross-members. It is so named by reason of the fact that the series of cross-bars resemble the bones of a herring.

Ans. 2—Perkins invented the method of engraving bank notes and the steam-heated bakery oven, as well as a considerable number of other less important pieces of machinery.

Ans. 3—Yes, the Chuse Engine Co. built several of this design. There were two pistons working in a cylinder having a center partition and steam chest. The pistons could be inspected by removing a part of the cylinder barrel.

Ans. 4—The Sickles steamboat engine, extensively used before the Civil War, employed poppet valves.

Ans. 5—The point of contact is not moving at all at any given instant. It may be assumed that this point, the center of the wheel and the point on the top of the wheel are three points on a lever swinging about the fixed contact point. Obviously the top of the wheel is at any given instant moving faster horizontally than is the wheel center.

Ans. 6—The lining prevents the corrosive gases reaching the steel, where they would dissolve in condensed moisture and corrode.

Ans. 7—It is used when the principal scale-forming materials in the water are carbonates of lime and magnesia.

Ans. 8—Since air has an exponent of 1.4 while steam has about 1.1, in the formula

$$\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^n$$

taking V_1 as the clearance volume, the volume at the beginning of compression, V_2, must be later with air to prevent the compression pressure rising too high. Usually, the clearance is made greater and the valve is left as when steam was used.

Ans. 9—Double-beat poppet valves.

Ans. 10—Rankine was professor of civil engineering and mechanics at the University of Glasgow. He developed the theoretical steam-engine cycle known as the Rankine cycle. All modern engines are compared with this perfect engine.

WHEN HAND-FIRING HEATING BOILERS with bituminous coal, it is generally conceded to be poor practice to cover the entire surface of the fire with green coal. This method is bound to result in dense smoke, a dirty boiler and lowered efficiency. An accepted method is to fire fresh fuel on the front of one side of the grate, then after it cokes and before coaling again, to push it forward or to the other side over the remainder of the grate, and then fill the vacant space with fresh coal. When firing is done in this manner, a portion of the fire always has burning coal on its surface that will ignite the gas distilling from the green fuel, and smoking is to a large extent prevented.

Alignment Chart for Determining Minimum Combustion Air and Maximum CO_2*

By C. Albert Kulmann
Consulting Engineer, Palo Alto, California

THE alignment chart for the determination of minimum combustion air and maximum CO_2 is particularly useful in interpreting reports on boiler tests which, ordinarily, do not give any measure of the excess air. In addition, it is easy, by means of this chart, to compare the actual CO_2 values with the theoretical maximum values for the fuel used, the analysis of the fuel being known.

The chart is based upon an equation for the amount of CO_2 in the waste gases when the minimum amount of air is supplied and the composition of the fuel is known. The equation used for the theoretical amount of air necessary is the usual one,

$$W' = 11.487\,C + 34.480\left(H - \frac{O}{8}\right) + 4.31\,S,$$

in which W' is the theoretical air supply necessary in lb., C is the carbon content, O is the oxygen content, H is the hydrogen content, and S is the sulphur content. The values of C, O, H and S are expressed as decimal parts.

The equation derived for the theortical amount of CO_2 is

$$CO_2 = 2.4027\,\frac{C}{W'}$$

in which CO_2 is the fraction, by volume, of the CO_2 in the dry flue gases, combustion taking place with no excess air.

Before the chart can be used, the amounts of oxygen sulphur and hydrogen and the carbon content of the fuel being used must be known. The procedure in using the chart is as follows:

1. Locate the point on Oxygen Content scale (axis at extreme left of chart) corresponding to oxygen content of fuel.

2. Locate the point on Sulphur Content scale (axis at extreme right of chart) corresponding to sulphur content of fuel.

3. Connect these points and locate the point where the line crosses reference axis No. 1 (second axis from left side of chart).

4. Connect this point on axis No. 1, to point on Hydrogen Content scale (second axis from right side of chart) corresponding to the hdyrogen value of fuel. Locate the point where the line crosses the reference axis No. 2 (third axis from right side of chart).

5. Connect this point on axis No. 2 with the point on the Carbon Content scale (third axis from left) corresponding to the carbon content of the fuel.

6. The point where this line crosses the scale of Pounds of Air per Pound of Fuel (center axis of chart) gives the minimum weight of air on scale A (scale on right side of axis).

7. Where this line crosses the scale of CO_2 values (inclined axis) gives the maximum percentage of CO_2 for the fuel.

In order to determine the amount of air for any other CO_2 value, it is only necessary to connect the same point on the Carbon Content scale with the point corresponding to the new CO_2 value and read the weight of air on the proper scale (center axis). When the A scale on the CO_2 axis is used, the A scale on the air scale should be used, and likewise with the B scales.

The weight of dry flue gas per pound of fuel can be found by subtracting from the air weight value (determined by the chart) the oxygen used by the hydrogen or $8.008\,H$, and adding the weights of sulphur and carbon per pound.

The dotted lines on the chart show the steps in determining the minimum air and maximum CO_2 for a coal of the following analysis: Oxygen, 17 per cent, or 0.17; sulphur, 1.1 per cent, or 0.011; hydrogen, 5.5 per cent, or 0.055; and carbon content of 67.5 per cent, or 0.675. The minimum air is 8.94 lb. and the maximum CO_2 is 18.1 per cent.

In using the alignment chart, it is not necessary actually to draw a line on the chart between the points located on the axis. A straight-edge laid on the chart between points will permit the location of the point on the third axis. Another desirable plan is the use of a silk thread instead of the scale.

As Applied to a Steam Engine, the real ratio of expansion is the number of times the actual volume of steam in the cylinder at the time of cutoff would be expanded to occupy the volume of piston displacement per stroke plus the clearance volume. With 6 per cent clearance volume and cutoff at 27 per cent of the stroke, the volume present at the time of cutoff would be $27 + 6 = 33$ per cent of the volume of piston displacement, and as the volume of piston displacement plus clearance volume would be $100 + 6 = 106$ per cent of piston displacement, the real ratio of expansion would be $106 \div 33 = 3.21$.

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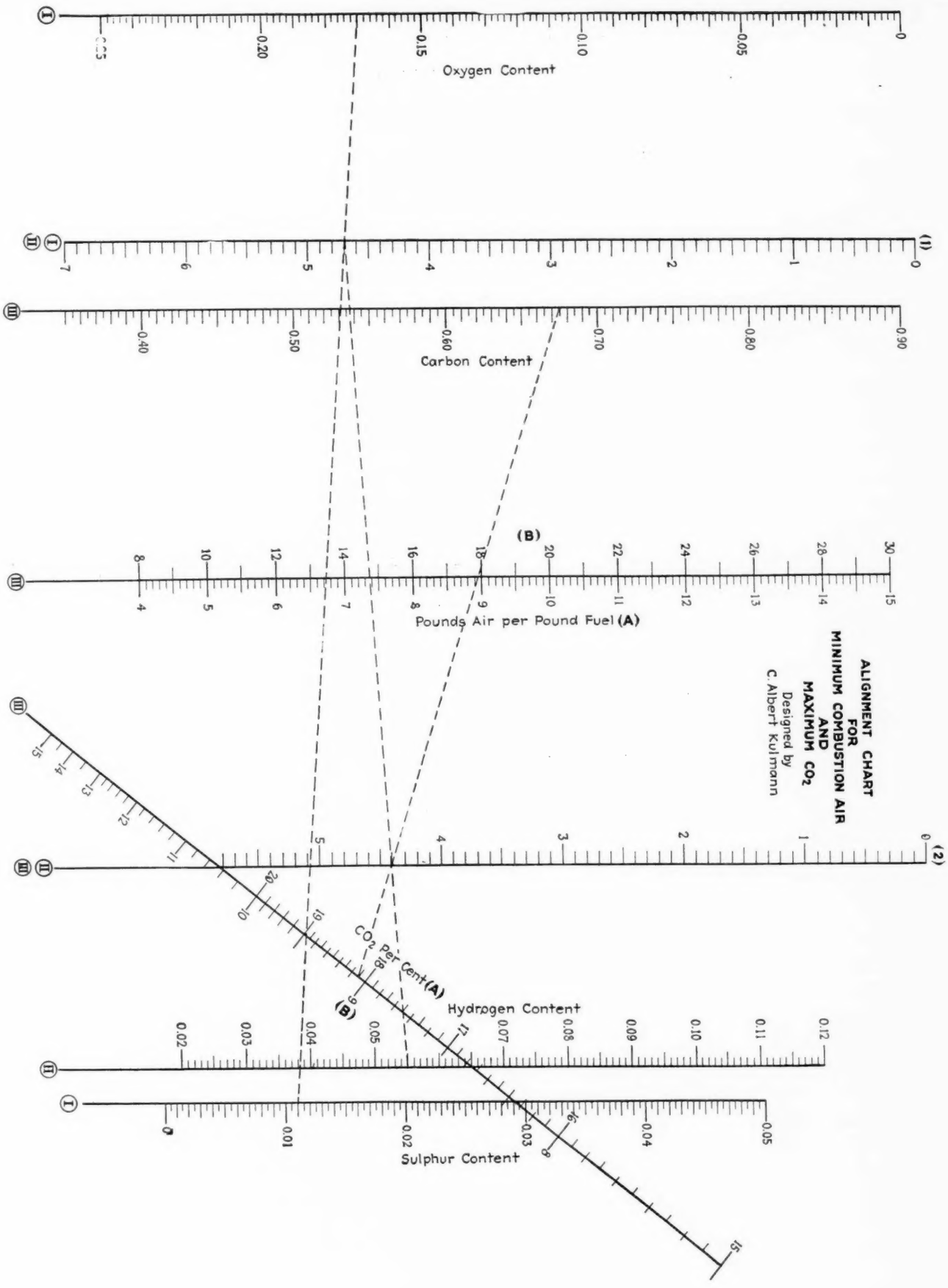

Oxygen Content
Carbon Content
(B)
Pounds Air per Pound Fuel (A)
ALIGNMENT CHART FOR MINIMUM COMBUSTION AIR AND MAXIMUM CO_2
Designed by C. Albert Kulmann
CO_2 per Cent (A)
(B)
Hydrogen Content
Sulphur Content

EDITORIALS

F. R. LOW, *Editor*

Emergency Lighting

EVEN in the best lighting distribution system there occasionally occurs a failure that affects a large section of a city or possibly a whole town. Public buildings, such as hospitals, theaters and hotels using central station service, are thus suddenly left without light, and the confusion resulting may well be serious. An emergency lighting system in public buildings that would take care of lighting hall lobbies and exits when the main service fails, would seem to be necessary to insure public safety.

A storage battery and charging equipment arranged to cut in automatically when the main service fails, is one method of providing for such an emergency. This type of installation would be uneconomical because of its infrequent use. Practically, the protection can be secured by installing a generator driven by an internal-combustion engine. This equipment installed to supply regularly all hall, lobby and exit lights, which in many cases are used nearly twenty-four hours a day, would operate at a high load factor. Because of this fact and the high efficiency of the internal-combustion engine this equipment should produce electric energy at less cost than purchased power, produce a saving sufficient to pay for its installation and provide light when the main supply fails.

The Rating of Low-Pressure Boilers

A CODE for the rating of low-pressure boilers formulated by a committee of the American Society of Heating and Ventilating Engineers is offered in *The Heating and Ventilating Magazine* of August for consideration.

It proposes that the capacity of a steam heating boiler be stated in terms of the amount of steam of at least ninety-eight per cent quality that it will generate, with the products of combustion leaving at not over seven hundred degrees F., with at least twelve per cent CO_2, with anthracite or coke or ten per cent with bituminous coal and with not more than one per cent of carbon monoxide.

There are many kinds of heating boilers, from those made up of cast-iron sections to water tubes of the regular power boiler type. The pressures at which they are run are generally low and not widely different. The condensate from the heating system is usually returned to the boiler, so that the feed-water temperatures are much the same. The performance can, therefore, be stated in pounds of steam per hour without that lack of definiteness and comparability that obtains with power boilers with their widely varying conditions as to feed-water temperature and pressure and quality of steam.

The limits of output will be reached when the boiler is driven at such a rate as to invite mechanical or other injury, when no further output can be obtained by increasing the draft and when objectionable priming sets in.

The committee considers that the first of these would be taken care of by the boiler specification and that the second would occur only at very high outputs and not be found in salable types. It finds then that the inherent limit of capacity of a steam boiler is its priming point, and this is the reason for the limit of two per cent of moisture.

The feature of the code that has been most criticised is the seven hundred degree flue-gas temperature, but it should be remembered that this is when the boiler is run at its maximum demand, on the coldest day during the heating-up period, while the average seasonal demand would be only one-third to one-half as great.

But the reasons for including the restrictions as to uptake temperature and flue-gas content are not convincing. It would appear much simpler to base the capacity on the output of steam, just as the capacity of a pump is stated in the amount of water it will handle per unit of time, and let the matter of efficiency be one for the individual contract. A boiler manufacturer or dealer could then guarantee to deliver so many pounds of steam per hour at such an efficiency, according to the fuel, draft and other conditions, and a lesser amount at a better efficiency. This would obviate the necessity of another code for gas-fired boilers which the committee has in prospect, and its equivalent would apply to hot-water heating boilers which this code is not intended to cover.

The committee admits that a method of rating based on equal or similar efficiencies at the rated output would be ideal in many respects, but the efficiency at the times of maximum demand is of secondary importance.

It would be inadvisable to include efficiency as a term in a standard capacity rating. Conditions affecting efficiency are too numerous. But the establishment of the practice of stating capacities in guaranteed output, and

specifying efficiencies according to circumstances, would unify practice, give its legitmate advantage to the boiler best adapted to the job and put a curb on the promise of impossible performances. If boilers sold under such a guarantee met the practical demands of the situation satisfactorily, acceptance tests would rarely be called for. If they were, the code as proposed includes all the necessary items for its determination except the heat content of the fuel, which could be determined by a testing laboratory for a small fee.

Safety First Pays

NOTWITHSTANDING the extensive experience with handling electrical circuits, serious accidents to workers coming in contact with live conductors and parts are still all too common occurrences. Most of these accidents can be prevented if proper precautions are followed. Hazardous conditions around electrical equipment occur under an almost unlimited number of circumstances. However, the experience with electrical apparatus has shown how these may be guarded against. Generally, where accidents do occur, someone has failed to observe some well established safety practice.

Because a piece of equipment has been out of service for some time it should not be assumed that an electrical potential does not exist on it. A transmission line, in proximity to another that is alive, may have a high voltage induced in it from the latter. Even when the line is isolated, high potentials may exist in it owing to the presence of storm clouds. If the line is dead when work is started on it, there is always the danger of its being made alive accidentally or by a potential introduced in it from some source.

Electrical equipment in power stations has associated with it the same hazards as power lines have, only the causes may be different. A dangerous shock may be received from an electrolytic-type lightning arrester after it has been disconnected from the line for hours. A piece of equipment may be apparently completely disconnected from all live circuits, but may be alive through some instrument transformer or other secondary circuit.

When tests are made to ascertain if equipment is dead, these tests cannot be relied upon absolutely, as the testing devices are not infallible. Even if the potential on the equipment tested is not high enough to show on the testing apparatus, it may be of sufficient value to be hazardous to workmen.

There are a few rules that, if rigidly followed, will prevent most accidents on high-voltage equipment. First, make sure that the apparatus has been properly cleared from the system before beginning to work on it. Then test it with an approved testing device, to determine that potential does not exist on any part of the equipment. After this has been done, the equipment should be effectively grounded. In this respect the recent report of the Accident Prevention Committee of the National Electric Light Association is worthy of careful consideration by everyone associated with electrical power apparatus. The most important reason for grounding electrical apparatus is to protect workmen from injury, but it may also prevent serious damage to equipment and serious interruption.

Manufacturers' Engineering Service

SOME of the large power equipment manufacturers abroad are accustomed to taking complete contracts for power stations, including all engineering design, supervision, construction and the furnishing of equipment.

Here such practice is unknown as concerns complete installations, although additions or alterations to plants are sometimes made from the manufacturers' plans. However, a pronounced feeling exists in this country against manufacturers performing engineering work that falls within the province of the consulting engineer. This view finds support from many angles. The consulting engineer, presumably, has a broad background of experience; he co-ordinates the functions of the various pieces of apparatus into the plant as a whole; he balances impartially the advantages and disadvantages of various types and makes of equipment; and finally, as the client's representative, he sees that the equipment meets performance guarantees.

On the other hand, the progressive manufacturer of today finds it necessary to employ a competent engineering staff whose experience and co-operation should be welcomed by the consulting engineer. These men are in a position to know their own products intimately. They have seen them operate under various conditions and in connection with related apparatus.

It is important that the equipment be adapted to the conditions under which it is to work and to the associated equipment in the plant. For instance, no longer can the boiler, the furnace and the stoker be considered separately, although made by different manufacturers, and the advice of each will be sought and weighed by the wise consulting engineer, however broad his experience. Unfortunately, there are some of limited experience but strong convictions, who spurn such advice. Many misfit installations stand as monuments to their convictions, and many an excellent piece of plant equipment fails to give the service of which it is capable because it never has had a fair chance. The reputation of the manufacturer is questioned and the owner's money is ill spent, all for lack of a common-sense regard for the specialized experience of the manufacturer's staff.

Without either usurping the duties of the other, let there be closer co-operation between the consulting engineer and the manufacturers' engineers to the end that no worth-while experience be wasted and better plants result.

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Roller Bearings Replace Plain Thrust Bearings

At the Windsor plant of Beech Bottom Power Company, Power, W. Va., there have been installed antifriction bearings on six steam turbine- and two motor-driven boiler-feed pumps, on two motor-driven condensate booster pumps and on eight motor-driven condensate hotwell pumps. The purpose of this change

Figs. 1 and 2—Marine-type and roller-type thrust bearings on boiler-feed pumps

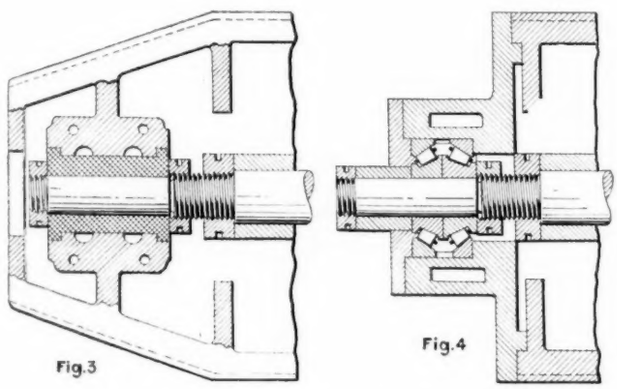
was to reduce the maintenance cost and improve reliability of service from the thrust bearings used on this equipment.

The 250-hp. centrifugal boiler-feed pumps operating at 2,800 r.p.m., previous to May, 1924, had to be dismantled and repaired at six-month intervals. Up to that time the thrust bearings were of the marine type consisting of a steel cone running against babbitt thrust rings, lubricated by a splash washer turning with the shaft. Any interruption to the oil flowing through the orifices in the rings resulted in wiping the babbitt from them. This permitted the shaft to shift, thus destroying the pump runners, wearing rings and diaphragms. The records show that as high as three thrusts have been installed on one pump in one day.

The operating department suggested roller-type in place of marine-type thrusts. Investigation showed that without any change in the pump housing an assembled Timken roller bearing could be used, and the change was made on one pump in May, 1924. This installation proved so successful that by October of the same year all the feed pumps were equipped with this type of thrust bearing. The advantages obtained are a 95 per cent reduction in maintenance cost, the pumps are now overhauled at eighteen-month intervals, and the cost of the roller bearing is less than 50 per cent of a marine bearing. Only one of the roller bearings has been changed, and the others show practically no wear. The exception was a broken roller taken from one assembly after two years' service. Fig. 1 shows a diagram of the marine-type thrust bearing originally used and Fig. 2 the roller bearing now in use.

The 10-hp. volute condensate booster pumps operating 1,750 r.p.m. were designed with thrust collars screwed on the pump shaft for adjustment against the split-babbitted ring-oiled bearings, as in Fig. 3. Water leaked along the shaft and flooded the oil from the inboard and outboard bearings, causing the babbitt to wear away. The shaft shifting in turn destroyed the pump parts. On these units new water-cooled solid bearing brackets were cast and machined to receive the assembled roller bearings, lubricated with grease, as in Fig. 4. Since installing these bearings in March, 1926, the maintenance cost on these pumps has been reduced 50 per cent with a corresponding reduction in outage hours, both of which are important items.

On the 100-hp. 1,760-r.p.m. centrifugal condensate hotwell pumps, previous to July, 1925, the thrust was adjusted in the same manner as on the booster pumps. This design of thrust bearing failed because of the pounding it is subjected to as the pump surges with the rise and fall of condensate in the hotwell. The shaft, shifting endwise, wore away the pump parts, which became unbalanced, setting up vibrations that caused the shafts



Figs. 3 and 4—Plain-type and roller-type thrust bearings on condensate pumps

to break. During the period from July to September, 1925, these pumps were all equipped with roller bearings by redesigning the housing brackets, as in the case of the booster pumps. The change has reduced the maintenance 25 per cent for material alone; the ready-to-serve factor has been increased considerably more, as the time to remove and install a roller bearing is a matter of an hour and the improvement in service hours has been equally beneficial.

W. L. COWDREY.

Power, W. Va.

Priming of Boilers Increases the Apparent Evaporation

THE priming of boilers in plants having no instruments exists to a greater degree than is generally suspected. In co-operation with another engineer I conducted a boiler test in a textile mill having hand-fired return-tubular boilers. After two days' test the evaporation of 9 lb. that we obtained was 3 per cent lower than the regular monthly average shown by the engineer's records. As we were there at the request of the superintendent, against the engineer's wishes, we had no co-operation from him and he took pains to advertise the fact that we could not apparently equal his showing.

The water meter was correct and the coal was weighed correctly, so I discussed the matter with the superintendent, who had all records in his office. A penciled item on his desk regarding yards of cloth produced weekly showed that he was in the habit of figuring the yards of cloth produced per ton of fuel burned, and as there were no steam meters available I decided to use these figures as a check on the evaporation. At the end of the week the superintendent's figures showed a 10 per cent reduction in coal per 1,000 yards of cloth, but the evaporation figured 3 to 4 per cent lower. This discrepancy made me suspect that the boilers had formerly primed, giving the engineer a false evaporation that was high. This was borne out to some extent when I learned that he had been in the habit of carrying his water level at 2½ gages, while we were careful not to exceed one gage of water.

There were no facilities for accurate testing, but we disconnected the trap on the main steam line at the discharge side to see how much water was being handled. Very little condensation appeared although the trap had a 1-in. inlet. Thinking the trap out of order, we disconnected the union on the inlet side and found the pipe to be nearly full of scale, the opening being less than ¼ in. This proved beyond argument that the boilers had primed, and the engineer was forced to admit that his true evaporation was less than he had expected as the mill output remained practically constant with 10 per cent less fuel burned.

A. F. SHEEHAN.

Springfield, Mass.

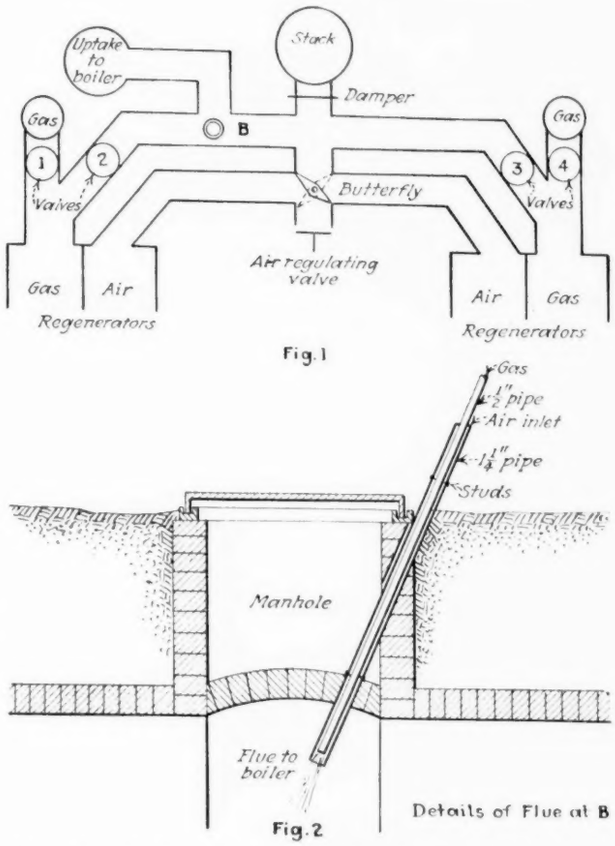
Prevention of Gas Explosions in Waste Heat Boilers

FOR many years a steam plant consisting of horizontal water-tube boilers utilizing waste heat from open-hearth furnaces, was troubled by rather violent explosions of gas, which occurred in the boiler setting when the flame in the furnace was reversed. These explosions were quite frequent, often occurring at every reversal, and were sufficientlly violent to do serious damage. At times the doors would be blown completely off and the brickwork destroyed. This also endangered men working near the boilers. Even when not so violent, the continual kicks kept the settings open, allowing the infiltration of cold air, which decreased the evaporation and seriously impaired the draft on the furnace.

The open hearth used producer gas as a fuel, and the layout of the underground flues is shown in a conventional manner in Fig. 1. Flame reversal in the furnace was effected by simultaneously closing valves 1 and 3 and opening valves 2 and 4, and swinging the butterfly valve to its alternative position, as shown by the dotted line. During this process there was a short period when all the valves were open, allowing green gas to be drawn back to the boiler and a draft of cold air to be drawn in at the butterfly valve. This gas and air formed a mixture at point *B* in the flue, which was chilled below its ignition point. The mixture then traveled up the hot flue to the boiler. By the time it was reheated, the red-hot soot in the boiler would ignite it, causing an explosion.

The cure was finally effected by placing a small coke-oven gas burner in the flue at the point *B*. The burner and its method of installation are shown in Fig. 2.

With this burner in the flue any gas or air mixture was ignited as it formed and burned harmlessly, completely preventing any explosions in the boiler. The burner itself used little gas, as much as would flow through 60 ft. of ½-in pipe with a differential pressure of 6 in. of water. It obtains its air down the outside pipe by the action of the draft in the flue.



Figs. 1 and 2—Arrangement of gas and air ducts and detail of gas burner placed in flue

The cost of making and installing the burners and the gas consumed are insignificant taking into consideration that it kept four men busy most of the time and used considerable quantities of material, repairing the walls and roofs. These men were released for other work.

The burners must be inspected regularly, and occasionally one has to be replaced owing to burning short.

This simple device solved a vexing problem.

Bethlehem, Pa. JOHN A. TAYLOR.

COMMENTS *from* READERS

What Makes the Boiler Drum?

IN CONNECTION with the letters that have appeared recently in *Power* on why boilers vibrate, I should be interested to know if anyone has solved the puzzle of why a boiler drums. This phenomenon has been known to drive a deaf man out of the boiler room. It is accompanied by a vibration that can shake loose bricks out of a side wall, crack and loosen arches and break windows.

In a plant with which I am familiar there is a 4,000-sq.ft. inclined-tube boiler set 5 ft. 6 in. from the floor to the center of the bottom drum. The furnace has had several arches and has recently been equipped with one of the most advanced type. The boiler is fired by a natural-draft traveling grate.

When conditions are right and the damper is opened a little too much, there is emitted, from no place in particular, a muffled groan accompanied by vibration which increases both in intensity and severity until it is impossible to converse in the boiler room. The pitch is deep and guttural, resembling the lowest note on a pipe organ but of many times the volume. The vibration is proportional to the moan or drumming sound.

The makers of the boiler offer no suggestions. Many engineers have seen it, heard it and offered solutions to cure the trouble. Most of the engineers have neither seen nor heard of such a thing before. But this is not the only boiler that drums. I have heard of others. Many have offered cures but none are permanent.

Alongside of this boiler is another practically the same. It is fired with the same fuel and it never drums, regardless of the rating or draft. This serves to increase the mystery. There are no holes in the baffles, the tubes are clean, the superheater is not loose and there are no holes in the fire. H. M. TOOMBS.

Chicago, Ill.

* * * *

Why Do the Boilers Shake?

REFERRING to the query of E. D. Hewlett in the July 5 issue, "Why Do Boilers Shake?" this is a trouble frequently experienced owing to improper combustion. It generally occurs when the plant is working at full load.

The following conditions are necessary for good combustion: (1) A sufficiency of air; (2) the air to be brought in intimate contact with the coal and the gases distilled therefrom, and (3) the mixtures of distilled gases and air to be maintained at a temperature of incandescence in order that the gases may be burned before they become cooled below the temperature of ignition by contact with the heating surfaces of the boiler.

I would suggest the use of some positive means to supply air below the grates such as a portable, electric- or steam-driven blower for experiment, and if proved satisfactory, a permanent installation should be made.

Boston, Mass. EARLE S. NASON,
Chief Machinist, U. S. Navy.

I HAVE had similar experience with a Garrett boiler and engine unit, known as the Locomobile. This boiler could be made to vibrate and hum at will on heavy load by fixing the draft in a certain position. This was more pronounced if the fire contained thin spots.

My theory of this phenomenon is that when the air enters the furnace through thin places in the fire and along the furnace walls, vibrations are set up by the increased velocity of the air and the rapid combustion of the gases which takes place above the fuel bed, miniature explosions taking the place of normal combustion. In normal operation the great part of the combustion takes place in the fuel bed, but in the instances just mentioned the majority of it takes place above the fuel bed and in the combustion chamber. This trouble can be overcome by avoiding thin spots and holes in the fire.

Shefford, England. W. E. WARNER.

MR. HEWLETT does not say whether there is a receiver ahead of the shotgun feed, and from his drawing it would appear there is not. Now, if the steam line is well supported and anchored, each time the sawyer opens or closes the valve, the pulsation will be carried back to the boilers and so cause them to shake. This can also be caused from the openings in the strainers being too small or partly plugged up. However, it would appear that the trouble in Mr. Hewlett's case lies in not having enough receiver capacity. JOHN BEST.

Snoqualmie Falls, Wash.

* * * *

How Long Has the Dry-Air Pump Been in Use?

IN LOOKING through a notebook of some twenty-five years ago, I came across what may prove to be of interest to *Power* readers.

There is a little incident connected with the condenser and air pump shown in the illustration. The plant was operated 24 hours a day and sometimes until six o'clock Sunday morning. In the good old days shifts were twelve hours and whatever extra time one might have to work should the other shift be late or not come at all.

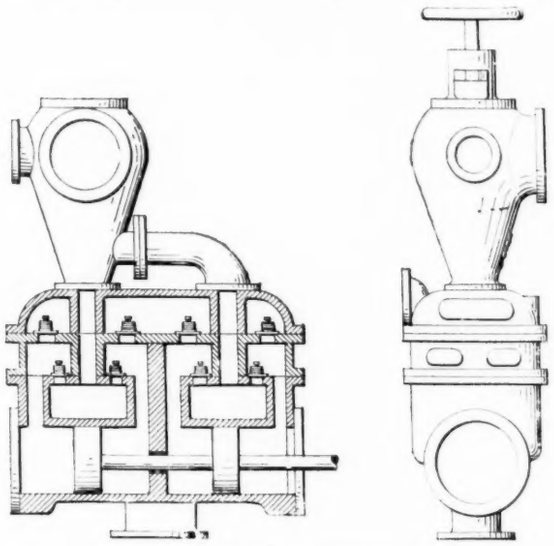
On one occasion the engineer on the morning shift dropped the vacuum from 26 down to 14 in. on one of a pair of cross-compound Corliss engines, but managed to complete his run without the vacuum's going any lower. This was in a rolling mill, and had the stock been hard or cold he would have been out of luck.

It was not unusual to find from four to six valves, springs and studs missing from the pump, but a survey

of the hotwell usually disclosed the missing parts. Imagine the engineer's surprise when he found only four valves missing and the vacuum down to 14 inches! When he pulled off the head to see if the packing was gone in the piston, *he found the piston off the rod!*

Whoever heard of a pump maintaining 14 in. of vacuum with the piston stopped? The accompanying illustration explains the mystery.

The outer piston—that is, the piston under the condenser—was off the rod, but the inner piston was still in service. Up to this time we did not know of the second piston. It seems possible that the designer of this apparatus intended one piston to be used as a wet pump and the other as a dry air pump.



Cross-section of condenser pump

There were two complete units, serving two cross-compound engines, and each unit contained 80 valves.

These pumps were at that time probably 20 years or more old, and that was between 25 and 26 years ago, so it would appear that 45 years or more ago dry-air pumps were thought of in this country. C. W. PETERS.

New York City.

* * * *

How the Boiler Feed by Means of Traps Was Made Automatic

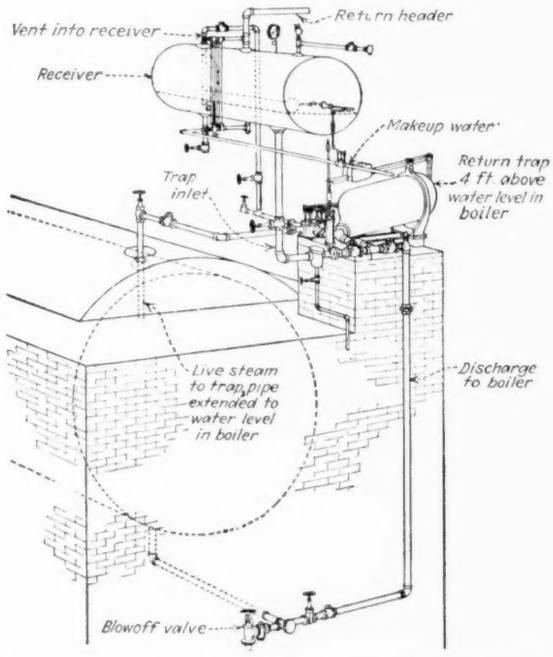
IN THE Aug. 23 issue C. W. Stevens describes a method of controlling the discharge of a direct-return steam trap so as to maintain a steady water line in a boiler. It consists of connecting the live steam inlet of the trap to the water line of the boiler instead of to main steam outlet. This is a simple and practical way to obtain such control. The idea, however, is not new. It has been used in numerous installations and is in fact part of the subject of a patent issued to the writer and assigned to the Crane Co. However, a discussion of the subject may not be amiss.

Mr. Stevens shows a vertical tubular boiler, and he has selected the middle try-cock as a point of connection for the live steam pipe of the trap, but in the case of boilers having their try-cocks on water columns, this would violate the Boiler Code. It is better practice to pass the pipe through the top of the boiler and carry it down to the water line, as shown in the illustration.

This gives desirable leeway in the height of the water carried, for it allows the water line to be raised by cutting off the end of the pipe, or lowered by extending it by means of a coupling and nipple. When the construction of the boiler precludes this method, similar results may be obtained by connecting a vertical pipe to the top and bottom of the boiler with a tee in the vertical pipe at the proper height. The latter plan gives quieter water at the inlet to the steam pipe of the trap, for it is not exposed to the priming action of the boiler, and this results in a somewhat steadier action of the trap.

Mr. Stevens introduces the makeup water directly into the boiler by means of a feed-water regulator, which, of course, is feasible only when the boiler pressure is lower than that of the supply, and even then it is open to the usual objections against feeding a boiler with cold water. A better plan is to mount the regulator on the receiver which supplies the direct return trap, so feeding the makeup water to the boiler along with the hot returns. This method also obviates any chance that the trap will be delayed in filling owing to lack of water, for the receiver will contain an ample supply, in the case of a high boiler pressure or a low-pressure water supply.

The receiver supplying the direct return trap should be placed several feet above the return trap, for there is



Return trap and receiver with connections arranged for boiler feeding

nothing but gravity to induce a flow of water from the receiver to the trap, so the higher the receiver the quicker the trap will fill, and, of course, the quicker the trap fills the shorter the time the boiler will be without feed and the steadier the boiler water line will be; besides, this will increase the feeding capacity of the trap.

The chief advantage of the direct-return trap over other methods of boiler feeding is the saving of heat, but Mr. Stevens sacrifices most of this by venting the receiver and the trap to atmosphere.

In a really closed system, having neither receiver nor trap vents, this waste would be avoided, and hence it

should be a rule, in designing any condensation return system, that no apparatus may vent except into its own supply or to a point of equivalent pressure, though an exception might be made when the steam vented can be used to profitable advantage.

This rule may be complied with in the case of a direct return trap provided with an overhead receiver, by attaching a thermostatic air valve to the vent of the receiver. This will purge the receiver of air and prevent air binding. Then the vent of the trap should be connected to the top of the receiver and carried down to the bottom, a "silencer" fitting being attached to its end to prevent rumbling in the receiver when the trap vents.

In the illustration it will be noted that a safety valve is attached to the receiver, the purpose being to relieve automatically any excess pressure that might arise by a trap somewhere in the system blowing through. An excessive pressure might keep some of the returns or the makeup water from entering, but with the safety valve the receiver pressure cannot go above a safe point, and the system will function in spite of defective traps.

When the return trap vents, its steam is absorbed by the water in the receiver, which absorption equalizes the pressures, and the water flows to trap as if both trap and receiver were open to atmosphere. This method of venting the trap has little or no effect upon the receiver pressure.

There are advantages beyond those already mentioned when the feeding is regulated in the manner described. Where the steaming rate is fairly even and the boiler is not overloaded, the water line in the glass is steady, indicating a practically even flow of water, but where boilers are subjected to varying loads, the rate of feeding will change inversely with the steam demand, which has a steadying effect upon the boiler pressure.

From the fact that a small boiler has been under discussion, it may appear that this system is adaptable to small plants only, but among the many installations with which I am familiar are included boilers up to 3,500 sq.ft. of heating surface, and batteries of as many as six boilers. It might be added that on a battery of boilers a separate return trap is used for each boiler, but one receiver serves all the traps. W. L. Oswald.

Caldwell, N. J.

* * * *

The Decrease in Students in Mechanical Engineering

IN THE Sept. 20 issue, James McIntosh, in commenting on the letter from Charles McCabe Smith, takes a pretty hard rap at the college man. Having served my apprenticeship and worked as a machinist and draftsman before entering college, I have seen both sides of the question and feel that both Mr. Smith and Mr. McIntosh have entirely overlooked the benefits derived from the diversified education received at college.

A controversy regarding the relative merits of the college graduate versus a practical engineer will probably continue through the years, and each addition to the controversy seems to throw new light on the situation and to call more and more to the attention of the practical man the points in which the college man seems to have the advantage. The fact that hard-headed business men are willing to invest in the training of the college man is sufficient proof that there is an advantage in an education, and an analysis of what this education means may add still another link to the chain. Education adds to the absorbability as well as the adaptability of the mind, and it is possible that this fact has as much to do with the advancement of the college man as any other.

Any man receiving an education must first of all learn a number of fundamental laws and then, during the rest of his education, must learn to apply these laws and to unite them into groups to form other laws. The result is a development of the ability to recognize and apply fundamental principles and to develop from these principles an understanding of advanced work.

Another point is that the college man must have developed the ability to learn his lesson consciously. When a certain lesson is assigned, the student must be able to study that lesson with the view of satisfying his instructor that he is familiar with the subject-matter contained, and the student, therefore, is consciously making an effort to absorb certain points of the text. Furthermore, he knows that he must be able to prove his knowledge. This proof may be in the form of a verbal recitation, blackboard demonstration or a written exercise, so that while studying the text he is constantly thinking of the explanation for the facts given in the text or searching for an explanation if one is not apparent.

The breadth of training given an engineering student in college also has a bearing on his development, for he must attend each class covering three or four different subjects which are not closely related. This leads to a form of mental gymnastics tending to develop the student's mind. With a recitation in chemistry followed by one in mathematics, which in turn may be followed by one in foreign languages, the student must develop the ability to put his mind on the subject which is most important for the moment and to absorb readily subject-matter pertaining to whatever branch of his studies he is immediately engaged upon.

The man who has gone through a four-year period of such conscientious mental development is naturally more adaptable to new work than one who has confined himself to routine work throughout a similar period of time and has concentrated all his efforts at one point. A practical man has little time for reasoning or investigation. His work must be done and done quickly, and all too often he relies upon similar experiences of the past without giving each particular job the thought and attention it deserves. The college man, being unhampered by past experiences, is likely to try anything that looks reasonable with results that are frequently ridiculous, it is true, but which, nevertheless, serve as a basis for sound reasoning and serve as a lesson well learned.

Unfortunately, the college graduate must wear out his college clothes and must get over the experimental stage before he is really useful, but once having passed this stage, he is better adapted to absorb new ideas, to understand and follow directions and to associate the things he sees with the theory learned than is the man who has devoted an equal time to acquiring a practical experience without getting in some way a theoretical training. If the practical man had the opportunity to develop and train his mind along a variety of subjects during the period of his practical experience and could receive training in the basic principles and fundamentals of the work he is doing, he would probably find that he was the equal of the man with a college training.

Scranton, Pa. R. B. Smith.

RECENT PUBLICATIONS

ELEMENTS OF HEAT POWER ENGINEERING. By W. N. Barnard, F. O. Ellenwood and C. F. Hirshfeld. Part I. Thermodynamics and Prime Movers, being the third edition of the first part of an older book under the same title, by Hirshfeld and Barnard. New York, John Wiley and Sons, Inc., 1926. Cloth; 6 x 9 inches; 493 pages; with illustrations and charts. Price, $4.50.

THIS volume is completely rewritten by Professors Barnard and Ellenwood, with substantially the scope of the first part of the original one-volume work, but with a new plan and treatment, embodying a number of novel methods of presentation as well as new developments worked out by the authors.

The spirit of the book is perhaps most strongly characterized by two commendable features: First, theory is linked with practice as closely as is consistent with an intelligent and complete treatment, and second, the development of theory is everywhere as complete and rigorous as is possible in the present state of the art, and all material is included in the text where it belongs, which is as it should be. The engineer desiring to go more intensively into some detail than he did in his early studies, will find in this book everything he may need in its logical position, along with the more elementary matters that make the book familiar ground.

The basic ideas of internal energy and heat content are introduced in the first chapter. This will tend to forestall the formation of misconceptions of which beginners sometimes find it hard to rid themselves. A similar innovation is the introduction in an early chapter of the general equations for the energy relations in cylinder processes and in steady flow, presented before the properties of any particular substance are introduced. This paves the way for the rational discussion of many complex processes and avoids the necessity for duplicating an initial simple description by a subsequent thorough analysis.

It is recognized that actual processes are irreversible, and yet that certain portions of the systems involved may execute processes that are sensibly reversible. This clear statement should conduce to clear thinking with reference to what is often a dilemma to the student. He is told that irreversible processes are not susceptible of analytical treatment, and he observes that all real processes, as a whole, are entirely irreversible to a pronounced degree, and yet he is taught to prepare elaborate analyses whose validity rests wholly upon a close approach to reversibility in the real process. This difficulty is cleared away by the authors.

Immediately following the discussion of gas processes in the abstract, is a chapter on compressed air that should serve to keep the theory in touch with actual practice. The analysis of the centrifugal compressor by means of the general energy equation of steady flow is illuminating.

In the treatment of internal-combustion engine cycles the authors introduce the "cold-air standard," the "hot-air standard," and the "real-mixture standard" gas cycles as criteria of ideal engine performance. Portions of this subject are intricate, but the authors have succeeded in developing a logical discussion that should be readily mastered by thoughtful readers. The presentation of the closest available approximation to the actual facts should prove valuable to all engineers, whether they check each step in the reasoning or simply accept the results as working formulas.

A contribution that should be appreciated by engineers is the development of a formula for the efficiency of the Diesel cycle that involves only quantities that are known, namely, the compression ratio, the cutoff ratio, and the average value of the ratio γ of the specific heats.

The detailed study of the theory of internal-combustion engine cycles is followed by a discussion of their application to practice in real engines. Clear distinction is established between cycle plots and indicator diagrams.

The properties of vapors are presented clearly and in general terms, without special reference being made to any single material.

For high-pressure steam cycles and engines, account is taken of the feed-pump work, and it is shown that for cases now within the realm of actual practice this is not negligible, as it is common to suppose.

The discussion of the cycles of operation of vapor prime movers is exceptionally well done. Clear distinction is made between the engine cycle and the vapor cycle, one indicating what happens in a cylinder, the other following the working substance around its course through the entire plant. This should help the reader to avoid many pitfalls of obscurity.

Moreover, the Rankine vapor cycle is correctly drawn and described as including isentropic compression of the condensate to boiler pressure. This has often been overlooked.

Reheating, regenerative and binary cycles are the subject of an interesting chapter in which the authors present their original suggestions for the treatment of these cycles—a subject that is extensively discussed among engineers.

Immediately following the chapters on the vapor cycles are chapters covering the reciprocating steam engine and the steam turbine.

The volume is evidently designed for use as a textbook in engineering colleges, and for this it seems well adapted in both form and substance. The treatment is such that the more complex parts may be omitted in short courses without breaking the continuity of the subject. While no effort seems to have been spared to make the work as easy as possible for the student to grasp, at the same time no subject has been slighted because of its difficulty. The instructor who can handle the book without some strenuous study on his own part may compliment himself on his mastery of the increasingly technical field of power generation from thermal sources. To those who want a thoroughly good book, this volume is to be commended.

FEDERAL AND STATE LAWS RELATING TO WEIGHTS AND MEASURES—Issued by the U. S. Department of Commerce, Bureau of Standards, comprising 976 pages, has been revised to present existing laws of the states, territories and insular possessions and of the federal government of the United States. This is the only publication in the field and includes federal laws and regulations relating to fundamental standards. The scope of the laws contained in this compilation and the wide application and interest which weights and measures have, in general, to the conduct of business, make this a valuable reference work and guide to a large number of different lines of business. Among such classes of business that may be mentioned especially are manufacturers of, dealers in or shippers in interstate commerce of measures and of containers as well as the commodies considered in the laws presented. Copies of this book may be obtained on application to the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, $2.30.

WATER RESOURCES PAPER NO. 52—The Dominion Water Power and Reclamation Service of the Departmnet of the Interior of Canada has recently issued Vol. 52 of the water resources papers, which deal with the surface-water supply of Canada. Paper No. 52 contains the results of investigations made by the Dominion Hydrometric Survey during the climatic years from Oct. 1, 1924, to Sept. 30, 1926, in the provinces of New Brunswick, Nova Scotia and Prince Edward Island, comprising the Atlantic Drainage in Canada south of the St. Lawrence River. The report contains a short explanation of the purpose and scope of the work and 76 pages of stream-flow data, with an index map showing drainage areas and the location of gaging stations. Copies may be obtained free of charge by application to the Director of the Dominion Water Power and Reclamation Service, Ottawa, Canada.

THE INDUSTRIAL TRANSITION IN JAPAN. By Maurice Holland, Director of Engineering Research, National Research Council. Published 1927 by the National Research Council, 29 West 39th St., New York City, and Japan Society, 36 West 44th St., New York City. Boards; 4¼ x 6¼ in.; 50 pages, with industrial map of Japan and decorative sketches. Sent on request.

THIS little book can be read in less than an hour. It tells in a most delightful manner what Mr. Holland learned about industrial Japan while attending the Pan Pacific Science Congress as a representative of the United States government and the National Research Council and other national organizations. That Japan has progressed remarkably in industry and science may not be news to America, but the facts disclosed in this book will undoubtedly astound most readers.

NEMA HANDBOOK OF SUPPLY STANDARDS. Published by the National Electrical Manufacturers Association, 420 Lexington Ave., New York City, 1927. Paper, 9x6 in.; 231 pages. Price $3.50.

THIS is a completely revised edition of the Nema handbook, which contains standards endorsed by 189 manufacturers of the supply division on air circuit breakers, attachment plugs, fuses, cutout bases, knife and enclosed switches, lamp receptacles and sockets, laminated phenolic products, metal molding, nonmetallic flexible conduit, outlet boxes, overhead trolley line materials, panelboard and distribution boards, signaling apparatus, and snap switches, with approximately 125 illustrations, diagrams of designs and methods and numerous tables and curves. These standards have been approved by the standards committee, the official body for the control of technical standardization within the Association. This handbook represents the experience and knowledge of practical and technical men, who have for years been most vitally concerned with the design, manufacture and installation of electrical supply equipment.

THE STORY OF CHEMISTRY. By Floyd L. Darrow. Published by the Bobbs-Merrill Co., Indianapolis, Ind., 1927. Cloth; 6x9 in.; illustrated. Price, $4.

DURING recent years there has been developed what may be called a new literature, in which technical subjects have been popularized and made easy reading, even to the layman. This new book comes in such a class. The statement that "facts may be more fascinating than fiction" is borne out in this work. Beginning with the alchemist of two centuries ago, a coherent story is told of the important developments that have taken place and that have led to the dominating position of chemistry in modern civilization.

This book is practically free from technical terms, and the author has made easy reading of what is generally considered formidable to the layman. The easy and pleasing style should make it a joy for even engineers, chemists and scientists to read about their own accomplishments. In some works of this kind the authors have taken poetic liberties with the facts, an accusation not applicable in this instance, as the treatment presents a wide range of knowledge drawn from many authoritative sources.

On account of the present general popular attention being given to the structure of the atom, the chapter on "Atoms, Electrons and Protons" is one of the outstanding parts of the work, and the author has succeeded in presenting the subject in a pleasing manner. Other chapters among the fourteen comprising the book are: Chemistry and Power; the Age of Metals; The Twilight Realm of Matter; American Progress in Chemistry; Research: The Key to Future Progress.

Chemistry has so permeated all branches of industry that it would be practically impossible to tell the story of the former without in a large degree relating the development of the latter, and in this work it is the double picture that is given.

OVERHEAD SYSTEMS REFERENCE BOOK A complete treatise on overhead transmission and distribution of electricity. Published by National Electric Light Association, New York. Size 8½x11 inches; 592 pages; 668 illustrations. Price, $7.50; to members of the Association, $5.

COMPLETE coverage of a highly important phase of the electric light and power industry has been achieved by the Overhead Systems Committee of the Engineering Section of the National Electric Light Association with the publication of its handbook, the "Overhead Systems Reference Book."

More than a handbook, this work is so comprehensive as to require but slightly less than 600 quarto pages. It represents the combined effort of hundreds of engineers connected with electric light and power companies in all parts of the country. Pooling the results of their work on the transportation of power, these engineers have cleared their information through the Overhead Systems Committee, and this compilation is the result of their efforts.

Although it is, in a way, a successor to the "Handbook on Overhead Line Construction," last printed in 1914 and out of print for some years, the new book has been completely rewritten and rearranged. The principal subjects, aside from tables and general information, are, in order: Wood Poles, Steel Poles, Towers and similar structures, Materials, Insulators, Transformers, Protective Apparatus, Street Lighting, Electrical and Mechanical Calculations, Methods of Construction, Meteorological Data, and Suggested Specifications.

All these subjects are presented in such a manner that they are directly applicable to modern conditions and they have, therefore, a freshness and practical usefulness that is often lacking when old material has been reworked. Through selection of the most desirable methods that are employed in this important work in various sections of the country, it has been possible to present in tangible and readable form the most approved and satisfactory methods. Replete with illustrations, drawings and information, the work is the last word in present-day construction and maintenance.

Appearing at this time, this textbook on overhead power lines assumes an added importance in view of the research work on power transportation started by the N.E.L.A. during the last year in various universities. Using the methods shown in this book as a basis, the research engineers are further investigating the subject with the view of possibly improving on the practices that have so far been selected as the best.

Realizing the hard usage that is the lot of all engineering reference books, the paper and binding for the "Overhead Systems Reference Book" were selected with unusual care. The paper was made to specification, and the binding was chosen for its durability.

DATA BOOK 615, a handbook on belt conveyors recently issued by the Link-Belt Co., Chicago, contains a fund of engineering data such as could be evolved only out of many years of research and practical experience in the design, construction and operation of belt conveyors handling all sorts of materials under a variety of operating conditions. Typical arrangements of belt conveyors and conveyor elements are followed by engineering suggestions dealing with operating conditions, selection of equipment for the service and typical problems in belt-conveyor design. Of special value to the designer is the abundance of data presented in tabular form, giving the horsepower required for various speeds and capacities, widths of belt, lifts and weight of material handled. General dimensions of typical belt conveyors are tabulated and other data giving the physical dimensions of terminal equipment. The new publication should be of great practical use to users of belt-conveyor equipment. It goes hand in hand with the "Typical Elevator Book No. 680" and the "Link Belt Silent Chain Drive Data Book No. 125." In these three publications the plan has been to so tabulate and arrange the fundamental facts, figures and examples as to make it easier for the potential user of such equipment to do his own designing and to make selections.

NEWS *of the* FIELD

New York Refrigerating Men Hold Meeting

The October meeting of the New York Section of the American Society of Refrigerating Engineers was held Oct. 17 at the Park Central Hotel, New York City. Present at this meeting were 112 members and guests.

The guest of honor of the evening was W. H. Carrier, president of the parent organization of The American Society of Refrigerating Engineers, who was introduced by President Bennis of the New York Section.

Mr. Carrier expressed the opinion that it was his desire to see the continued and steady growth of an ultimate organization that would be what he would term a thermal engineer, that is, the relations between the refrigerating engineers and the heating and ventilating engineers are becoming so close that it is difficult to see where ones work starts in and the other leaves off. In the future Mr. Carrier believes that this association of these two bodies will become more assimilated.

Theater Ventilation

Mr. Carrier told of his recent trip to Detroit where there was lately installed the Detroit section and the enthusiasm shown in the development of this new section, Mr. Carrier said, should be an incentive for other local sections to develop and thus enhance the general advantage of the national organization.

L. L. Lewis of the Carrier Engineering Company, read a paper entitled "Recirculation in Theater Cooling." Mr. Lewis augmented his talk with lantern slides showing in detail the general construction of the modern theater and the general plan in installing cooling systems in theaters and the distinct advantage that can be gained by the recirculation of the air. In the direct cooling method where air is drawn in from the outside and there is no circulation or return, the tons of refrigerant required are far in excess of that required when both circulation and return are used. This reason, as pointed out by Mr. Lewis, was the large amount of heat available from the air extracted from the theater and using this energy reducing the amount of cooling effort that would be needed.

Following Mr. Lewis' paper and a general discussion, the members adjourned to the Roxy Theater where they had a first hand opportunity of seeing the present Carrier Cooling System.

Fund Given Purdue for Gas Engineering Research

Purdue University has lately received $50,000 from the Indiana Gas Association for the establishment of a chair in gas engineering for a research professor, who will take up studies of interest to gas engineering in general and Indiana in particular.

The problems to be taken up for special attention are complete gasification process, use of Indiana coal in the manufacture of gas, most practical B.t.u. from the standpoint of least oil in water gas considering plant investment. Provision will also be made for one graduate course and one undergraduate course in gas engineering.

Rochester Gas & Electric Complete New Units

Two new projects, a steam heating plant on Mount Read Boulevard and a new generating unit at the Lower Falls of the Genesee River, were put into service Oct. 28 by the Rochester Gas & Electric Corporation, Rochester, N. Y. The two enterprises represent a total investment of $1,750,000, according to Thomas H. Yawger, superintendent of the electric department.

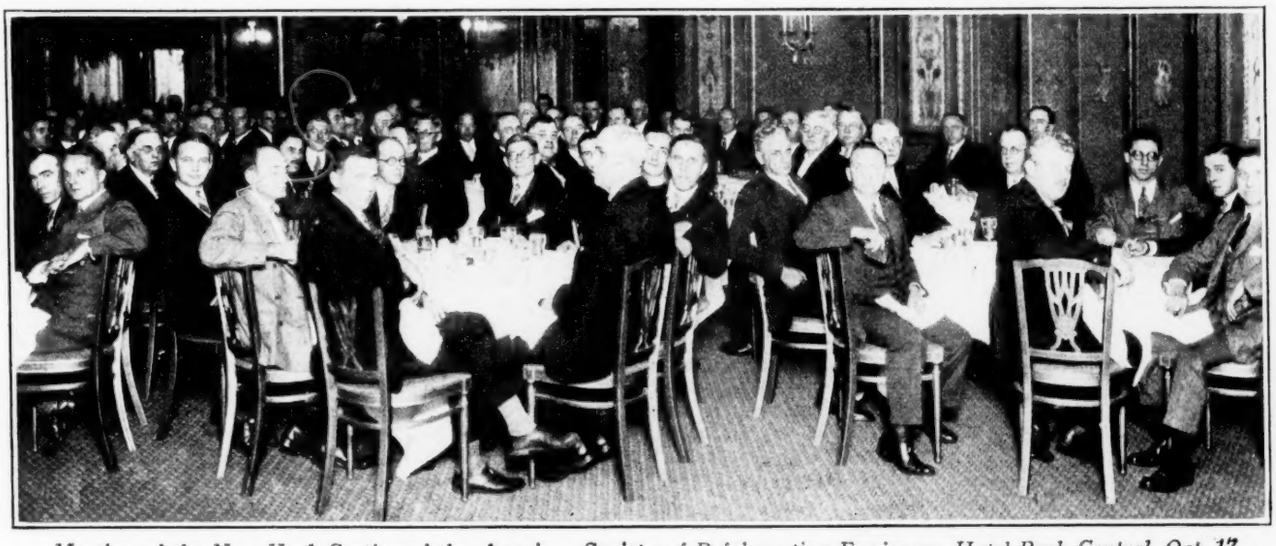
The new 25,000-hp. generating station, situated near Driving Park Avenue, was begun early last spring. Its completion has made possible the theoretical ultimate power development of the lower falls. With this station in use, the company will be able to realize complete use of a three million-dollar tunnel, built a few years ago, and to take further advantage of waste waters of the Barge canal harbor, conserved by building the new dam at Court Street.

Steam Heating Project

Among the features of construction of the new unit was rebuilding of Station 5, in which it is located, draining of the large tunnel to install the generator, and lowering of a 108-ton revolving field into the power room.

The new Lincoln Park steam plant was built principally as a steam-heating project, and will furnish heat for the General Railway Signal Company's plant and office buildings. It is a replica of the company's plant in Lawn Street.

The Lincoln Park plant is near the New York Central Railroad Company's tracks, making it possible to unload coal directly from the cars into the plant.



Meeting of the New York Section of the American Society of Refrigerating Engineers, Hotel Park Central, Oct. 17

Manning, Maxwell & Moore Form Operating Companies

For the purpose of co-ordinating the manufacture and handling of their products, Manning, Maxwell & Moore, Inc., New York City, recently organized two operating companies called respectively the Consolidated-Ashcroft-Hancock Company and the Shaw Crane-Putnam Machine Company, according to announcement Nov. 1.

The formation of the Shaw Crane-Putnam Machine Company, Inc., resulted from the combination of the Shaw Electric Crane Company, Muskegon, Mich., and the Putnam Machine Company, Fitchburg, Mass., including both works and sales activities. The operations of the Shaw Crane-Putnam Machine Company, Inc., will include the engineering development of new mechanical machines and devices, as well as the manufacture and sale of the present line electric traveling cranes, heavy machine tools for industrial and railroad service and special production machinery.

The Consolidated-Ashcroft-Hancock Company, Inc., combines the Hancock Inspirator Company and the Hayden & Derby Manufacturing Company, Boston, and the Ashcroft Manufacturing Company and the Consolidated Safety Valve Company, Bridgeport, Conn. The operations of this corporation will embrace the development of new devices for power plants, steam locomotives and marine service, as well as the manufacture and sale of the present extensive line of steam specialties.

The two companies will be operated under the sole ownership of Manning, Maxwell & Moore, Inc., the supplies department and the Chicago machinery branch office being retained. The officers of the parent corporation are: C. A. Moore, Jr., president; H. D. Carlton, E. M. Moore, F. J. Baumis, J. D. Micklis, vice-presidents; F. W. Knowles, comptroller, and F. M. Kreiner, secretary and treasurer.

Europe's Largest Power Plant Nearing Completion

The construction of what will probably be the largest hydro-electric station in Europe is now nearing completion.

It is located in Umbria, about 60 miles from Rome, and is at present capable of producing 400,000 hp., which can be increased to 500,000 hp. This station is in the valley of the River Yelino, which has been almost completely deflected from its original course and led into large underground tunnels as far as Papigno.

The amount of water thus taken and placed at the service of the station is 40 cu.m. per sec., and at favorable seasons of the year may reach 200 cu.m., while the fall is 200 cubic meters.

The whole water supply line is 2,000 m. long. The first 150 m. takes the form of two parallel pressure tunnels, which have a section of 25 sq.m., and passing under the Terni-Aquila Railroad, converge in the terminal zone in a large open canal 1,000 m. long. The water of the pressure tunnels passes into the canal and is afterward again taken to the power station. From the station the water is carried into the River Nera.

E. H. Lundgren Promoted by Combustion Engineering

Edwin H. Lundgren, who for the last four years has been general sales manager of the Combustion Engineering Corporation, has recently been elected vice-president and general sales manager.

Edwin H. Lundgren

Mr. Lundgren is well known in the power plant field, having been actively identified with the stoker business since 1912. His association with the Combustion Engineering Corporation began in 1921, at which time he resigned as vice-president and chief engineer of the Frederick Engineering Company, Frederick, Md., to come to New York.

Mr. Lundgren is a graduate of the Swedish Government Technical College with a degree of mechanical engineer. He is an authority on the design and construction of stokers and the author of numerous technical articles.

Central Maine Power Starts Building of Power Plant

The Central Maine Power Company announced Oct. 28 that work has been started on the construction of a power house and generating station on the Lewiston side of the Androscoggin River at Deer Rips, and that the company anticipates that the work will be completed by June of next year.

This new generator is expected to utilize the water power that is now going to waste over the big dam at Deer Rips.

David Williams, Publisher of *The Iron Age*, Dies

David Williams, publisher and sole owner of *The Iron Age* from 1868 to 1909, died at his home at Rogers Rock, Lake George, N. Y., Oct. 29, aged 85 years.

He was born in Waterford, Ireland, Dec. 23, 1841, and came with his parents to the United States in 1850. His father, John Williams, received his early business training as a hardware salesman; his first engagement in the United State was with the saw manufacturing firm of Wheeler, Madden & Bakewell, Middletown, N. Y.

David Williams graduated from the Middletown Academy in 1857. Two years previously his father began the publication at Middletown, of a trade journal known as the *Hardwareman's Newspaper*. David Williams, who had learned the printers' trade, had to do with the mechanical part of the business. The journal first appeared under its present name, *The Iron Age*, in April, 1859. The reasons for the change of name were given at length in the leading editorial of that issue.

John Williams was a patriotic Irishman, and one reason for his emigration to the United States was that his activities as a nationalist had to some extent embarrassed his career. On entering upon his new life in this country, he was naturally enthusiastic in the promotion of American industry, believing that the American market was destined to free itself more and more from dependence upon the manufacturers of Great Britain.

David Williams was a charter member of the Engineers Club and a member of the American Institute of Mining Engineers.

Gulf States Utilities Add Unit to Neches Plant

Extension of the Neches station of the Gulf States Utilities Company, which is controlled by the Engineers Public Service Company, will include the installation of a 35,000 kw. turbine-generator unit, together with the necessary condensing equipment, according to announcement. The new apparatus will be built at the South Philadelphia Works of the Westinghouse Electric & Manufacturing Company and installed in the extension of the Neches station when finished, which is being built by Stone & Webster, Inc. at Beaumont, Texas.

The turbine will be of the single cylinder type operating at 1,800 r.p.m. Steam will be supplied to the throttle at 350 lb. gage pressure, 700 deg. F. total temperature and exhaust at a pressure of one and one-half inches of mercury.

The generator will be rated at 35,000 kw., 80 per cent power factor producing 3 phase, 60 cycle current at a potential of 13,800 volts.

Yorkshire Electric Power Co. Opens Big Plant

The new super-station of the Yorkshire Electric Power Company, Ltd., has just been opened at Ferrybridge, near Pontrefract, England.

The section of the station now in operation contains two 26,000-hp. turbine generators, bringing the total generating plant installed there and at the company's stations already existing at Thornhill, near Dewsbury, and at Barugh, near Barnsley, up to 120,000 hp. The Ferrybridge site includes land available for extensions to bring the station's capacity up to at least 250,000 horsepower.

The site is directly connected by private siding with the main Sheffield-York railroad, and is directly alongside the River Aure and the Great North Arterial Road. The electrically driven plant enables coal delivered at the works, whether by rail, water or road, to be elevated automatically to the boiler-house bunkers or placed to reserve. Water for the boilers is taken from the river by screens and pumps capable of delivering 50,000 gal. per minute.

The turbines running at 3,000 r.p.m., are of the tandem reaction type, each having three cylinders, from the last of which the steam exhausts into twin surface condensers below the turbine. The alternators are operated at a voltage of 11,000, and are among the largest in the world running at that speed. This energy is conducted to outdoor transformers, and thence, at a pressure of 33,000 volts, to the main switch-gear, which is housed in a separate building.

Obituary

J. JARVIS PREBLE, for the last two years vice-president of the Spray Engineering Company, Boston, Mass., died Oct. 20. Mr. Jarvis was associated with that company for fourteen years.

NORMAN SPEAR LAWRENCE, vice-president and director of sales of the Whiting Corporation, Harvey, Ill., died Oct. 26 after a brief attack of pneumonia. Mr. Lawrence was born May 9, 1882, at Chicago, and was educated in the schools of Chicago. He graduated from Cornell University in the class of 1904 as a mechanical engineer, and shortly afterward entered the employ of Whiting Corporation as an estimator, becoming successively chief estimator, assistant sales manager, vice-president and director of sales. During the past few years he was also president of the Swenson Evaporator Company, a subsidiary of the Whiting Corporation. Mr. Lawrence had a wide acquaintance in the iron and steel manufacturing field and played an active part in the various business organizations, such as the American Foundrymen's Association, Foundry Equipment Manufacturers' Association, Electric Overhead Crane Institute and others. He was a member of the Flossmoor Country Club, the South Shore Country Club, University Club of Chicago, the Theta Delta Chi Fraternity and the A.S.M.E.

HARRY L. BROWN, secretary of the Ohio Brass Company and formerly editor of the *Electric Railway Journal*, died at Toledo, Ohio, Oct. 23. He was stricken with appendicitis while returning home to Mansfield after attending the Ohio-Michigan football game at Ann Arbor and did not recover from the shock of the operation which it was deemed necessary to perform at once. He served the McGraw-Hill Publishing Company, Inc., ten years, starting as an editorial apprentice in the capacity of assistant editor of *Electrical World* in 1915. For two years after he was graduated from the University of Michigan and before taking up editorial duties, he was engaged in engineering work with the Aurora, Elgin & Chicago Railroad and the Chicago Telephone Company. During the war he was first lieutenant and captain in the Signal Corps.

Personal Mention

PROF. CARLOS DE ZAFRA, of New York University, will occupy the post of director of the Engineering Index Service now being inaugurated by the A.S.M.E., as reported in *Power*, Oct. 25.

W. A. SHOUDY, consulting engineer, announces the removal of his office from 165 Broadway to 50 Church St., New York City.

H. MCVAY, formerly power engineer with the Utica Gas & Electric Company, is now superintendent of power for the Staten Island Edison Company, Livingston, Staten Island, N. Y.

C. A. REED has been appointed Pittsburgh district manager of the Erie City Iron Works with office at 1230 Park Building, Pittsburgh. For the last eight years he has been identified with the Combustion Engineering Corporation.

J. R. EDWARDS has been appointed manager of sales for the Erie City Iron Works, Erie, Pa. Mr. Edwards was formerly Western sales manager for the Pittsburgh Steel Company. He has been associated with the steel industry for the past fourteen years mainly in the sale of tubular products.

J. R. LEVALLY, who is special representative for the Erie City Iron Works, Erie, Pa., was for two years chief operating engineer at the Armour Company, Chicago. In 1917 he became engineer officer, U. S. Navy, in charge of engine rooms of U. S. S. "Vermont" and later became chief engineer of U. S. S. "Huron."

C. O. HOBAN, who has become special representative for the Erie City Iron Works, Erie, Pa., has done independent steel mill consulting work and for the last seven years has served as erector traveling engineer for the Riley Stoker Corporation. The last three years he has served as district manager of the Pittsburgh office.

JOEL ECKLUND has become a sales engineer at the Erie City Iron Works, Erie, Pa. For three years he held the position of engine designer with the Allis Chalmers Company at Milwaukee. He served twelve years with the United States Gypsum Company, where he held positions as designer, chief draftsman, chief designing engineer and process engineer of development.

Society Affairs

DETROIT ENGINEERING SOCIETY, Nov. 16, 478 West Alexandrine Ave., Detroit, "Application of Engineering Principles to the Purchase of Materials and Equipment," by Professor C. F. Hirshfeld, research division of the Detroit Edison Company.

ENGINEERS' CLUB OF LEHIGH VALLEY, in joint meeting with the A.S.M.E., at Drown Hall, Lehigh University, Bethlehem, Pa., Nov. 8, at 8 o'clock, will hear some new methods in furnace wall construction described by E. G. Bailey, president of the Fuller-Lehigh Company.

A.S.M.E., ONTARIO, Nov. 16, Brantford, Ont., at 8:00 p.m. This will be a Joint Meeting with the Grand Valley Section of the Association of Professional Engineers of Ontario. "Contract Law" by W. G. Hanna, legal department of the Hydro Electric Power Commission of Ontario.

A.S.M.E., METROPOLITAN SECTION, Power Division meeting, Nov. 10, at 8 o'clock in the Brooklyn Edison Company auditorium, Pearl and Willoughby Sts., Brooklyn, N. Y. J. N. Landis, plant equipment engineer of the Brooklyn Edison Company, will speak on Engineering analysis and the selection of size and type of power plant equipment. Also, L. V. Bonnett, purchasing agent of the Brooklyn Company, will speak on competitive purchasing and evaluation of proposals for power plant equipment.

AMERICAN REFRACTORIES INSTITUTE will hold meetings at the Hotel Chase, St. Louis, Mo., Dec. 6-7. Papers of interest will include "Dry Grinding of Refractories," by Mr. J. M. Gallaher, works manager, Clearfield Machine Company, Clearfield, Pa., and "Burning Refractories with Stokers," by Massillon Refractories Company, Massillon, Ohio. Inquiries concerning sessions should be directed to the secretary of the American Refractories Institute, 2202 Oliver Building, Pittsburgh.

A.S.M.E., METROPOLITAN SECTION, Aeronautic and Oil and Gas Power division meeting, Nov. 22, at 8 o'clock in the Engineering Societies Building, 29 West 39th St., New York City. "The Oil Engine and Aeronautics," Commander E. E. Wilson, U. S. N., head of engineering section, Bureau of Aeronautics, Navy Department, Washington, D. C.; "Heavy Oil Engines for Aircraft," D. R. Pye, deputy director of scientific research, British Air Ministry, and "Experiments in Fuel Injection for Aeronautical Engines," W. F. Joachim, National Advisory Committee for Aeronautics.

Business Notes

The JAMES E. DEGAN COMPANY, Detroit, wholesaler of steamfitting and mill supplies, announces that it has become a distributor of Walworth valves. The complete lines of iron, brass and steel valves manufactured by Walworth Company will be carried and are now available at the Degan Company warehouse, 622-624 First St., Detroit. The stock will include Walworth valves suitable for all service requirements on steam, water, gas, air or oil lines.

The WELLMAN-SEAVER-MORGAN CO., Cleveland, has announced the incorporation of an associated company in Canada known as the Canadian Wellman-Seaver-Morgan Company, Ltd., with head office at 307 Reford Building, Toronto, and branch office at 808 Drummond Building, Montreal. The Canadian company will handle the parent company's products, which include coal and ore handling machinery, cranes, port and terminal equipment, gas producers and other specialties.

THE HENDRICK MANUFACTURING COMPANY, Carbondale, Pa., manufacturer of Mitco interlocked steel floor grating, Mitco Shur-site stair treads and Mitco Armorgrids announces the appointment of the following representatives: J. E. Beattie, Greenville, S. C. Boiler Equipment Service Company, Candler Building, Atlanta, Ga.; Latex Steel & Machinery Company, San Jacinto Life Building, Beaumont, Tex., and W. A. Sedwick Company, 401 Construction Industries Building, Dallas, Tex.

Trade Catalogs

EXPANSION JOINTS—Mogul Machine Company, Philadelphia, describes Mogul double-end-guided expansion joints in a well illustrated and arranged catalog divided into two sections, the first containing general descriptive matter and illustrations, and the second specifications and dimensions. These joints are made in all standard pipe sizes from ¾-in. to 72-in. diameters. They are made in several types of construction and of various metals, all suitable for different fluids, pressures and temperatures.

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Engineering Council, annual meeting will be held in Washington, D. C., Jan. 9-11; L. W. Wallace, executive secretary, 26 Jackson Place, N. W., Washington, D. C.

American Institute of Electrical Engineers, Great Lakes District regional meeting at the Hotel Drake, Chicago, Nov. 28-30, Address J. E. Kearns, chairman registration committee, General Electric Company, 230 South Clark St., Chicago.

American Society of Heating & Ventilating Engineers, hold general meeting in New York City, during 4th week in January; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Refrigerating Engineers, annual convention in New York, Dec. 5-7; W. H. Ross, sec., 37 W. 39th St., New York City.

American Water Works Association. North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill; Section, at Council Bluffs, Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

American Society of Mechanical Engineers, convention during week of New York Power Show, New York City, Dec. 5-10; Calvin Rice, sec., 29 West 39th St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 14-17; G. E. Pfisterer, sec., 53 West Jackson Blvd., Chicago.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibitica in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National District Heating Association, annual meeting in May; D. L. Gaskill, sec. 112 West 4th St., Greenville, Ohio.

New York Power Show (National Exposition of Power and Mechanical Engineering) will be held at the Grand Central Palace, New York City, Dec. 5-10. Address inquiries to the International Exposition Co., Grand Central Palace.

Society of Naval Architects and Marine Engineers, Thirty-fifth general meeting will be held in the Engineering Societies Building, 29 West 39th St., New York City, Nov. 10-11. Papers of interest to power engineers will be offered Nov. 11.

National Engineers' Beneficial Association, Fifty-third annual convention will be held in Washington, D. C., Feb. 14. Headquarters to be announced hereafter; Albert L. Jones, secretary treasurer, 313 Machinists' Bldg., Washington, D. C.

Power Transmission Association. Annual meeting, Hotel Commodore, New York City, Dec. 7; W. S. Hays, Sec., Drexel Building, Philadelphia.

TURBINES—The Terry Steam Turbine Company, Hartford, Conn., has issued a new bulletin which describes the Terry wheel turbine. The Terry wheel is an especially designed power producing rotor manufactured from a steel forging without inserted buckets. The bulletin gives a short history of the company, the application of the Terry wheel turbine, its advantages, its principle of operation, a detailed description of its parts—including the various types of governors, a description of the Terry vertical turbine, a description of the Terry turbine for high steam pressures, the general design features of Terry turbo-generator units, pump drives, blower drives, paper machine drives, pulverizer drives, the Terry gear and the Terry shaft coupling.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Oct. 26 1927
Pool 1	New York	$2.35@$2.75
Smokeless	Boston	1.48
Clearfield	Boston	1.60@ 1.85
Somerset	Boston	1.70@ 1.90
Kanawha	Columbus	1.40@ 1.60
Hocking	Columbus	1.50@ 1.75
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.10@ 1.25
Franklin, Ill	Chicago	2.25@ 2.50
Central, Ill	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.35@ 1.50
S. E. Ky.	Louisville	1.40@ 1.75
Big Seam	Birmingham	1.65@ 2.00
Anthracite (Gross Tons)		
Buckwheat No. 1.	New York	2.90@ 3.25
Buckwheat No. 1.	Philadelphia	3.00@ 3.75
Birdseye	New York	1.60

FUEL OIL

New York—Nov. 3, light oil, tank-car lots, 26 deg. Baumé, 5c. per gal.; 28 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Oct. 20, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.4c. per gal.; 38@40 deg., 5¼c. per gal.

Pittsburgh—Oct. 27, f.o.b. local refinery, 30@40 deg., fuel oil, 4¾c. per gal.

Philadelphia—Oct. 27, 26@30 deg., $1.60@$1.66 per bbl.; 13@19 deg., $1.56 @$1.62 per bbl.; 22 plus, $1.79@$1.85 per bbl.; 27@30, $2.10@$2.16 per bbl.

Cincinnati — Nov. 1, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Oct. 29, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 87½c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—Oct. 31, tank-car lots, f.o.b., 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5¾c. per gal.

Dallas—Oct. 29, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

NEW PLANT CONSTRUCTION

Calif., Glendale — Professional Building Co., 1052 West Sixth St., is having preliminary plans prepared for an 8 story office building including steam heating system, elevators, etc., at Wilson St. and Maryland Ave. Estimated cost $500,000. W. S. Hebbard, 664 I. W. Hellman Bldg., is architect.

Calif., La Jolla—W. G. Clark, et al., Insurance Exchange Bldg., Los Angeles, plans the construction of a hotel here. Estimated cost $1,000,000.

Calif., Los Angeles—Chamber of Mines & Oil, c/o Walker & Eisen, Western Pacific Bldg., Archts., having preliminary plans prepared for the construction of a 13 story office building at 10th and Olive Sts.

Calif., Los Angeles—Foreman & Clark, Los Angeles Men's Clothing Firm, will receive bids about Nov. 20, for a 13 story office building, including steam heating system, elevators, etc., at 7th and Hill Sts. Estimated cost $800,000. Curlett & Beelman, 1020 Union Bank Bldg., are architects.

Calif., Los Angeles—J. N. Riesenberg is having plans prepared for an 8 story apartment building including steam heating and electric refrigeration systems, etc., at 9th and Calatina Sts. Estimated cost $550,000. J. M. Haenke, 1120 Subway Terminal Bldg., is architect.

Calif., Pasadena—First Trust & Savings Bank and First National Bank, awarded contract for a 9 story bank building at Colorado St. and Madison Ave., to J. V. McNeil Co., 5860 Avalon Blvd. Estimated cost $1,000,000. Steam heating system, elevators, etc., will be installed.

Calif., Riverside—Elwood Lloyd, F. Nansen & Associates, are having plans prepared for the construction of a hotel including steam heating system, etc. Estimated cost $1,000,000. J. M. Haenke, 1120 Subway Terminal Bldg., Los Angeles, is architect.

Colo., Pueblo—P. H. Philbin, Congress St., is having plans prepared for an 8 story office and stores building including steam heating system, boilers, elevators, etc. on Main St. Estimated cost $1,000,000. E. C. Groves, 1982 Broadway, Denver, is architect.

Conn., Bridgeport — American Hotels Corp., 25 West 45th St., New York, N. Y., awarded contract for the construction of a 14 story hotel here, to Wark Co., 1600 Walnut St., Philadelphia.

Conn., Hartford—Hartford Electric Light Co. has been granted permit to construct a power plant at South Meadows. Estimated cost $200,000.

Conn., Sterling — U. S. Finishing Co. awarded contract for a silk finishing plant and pump house unit to Pierce & Gaetz, 42 Weybosset St., Providence, R. I. Estimated cost $100,000.

Ill., Chicago — Lewis Building Corp. awarded contract for a 7 story hotel including boiler room and heating plant to W. G. McNulty & Bro., 58 East Washington St. Estimated cost $550,000.

Ill., Chicago — Michigan-Chestnut Bldg., Corp., c/o Frankenstein & Co., 110 South Dearborn St., is having plans prepared for a 6 story office and stores building at Michigan Ave. and Chestnut St. Holabird & Roche, 104 South Michigan Ave., are architects.

Ill., Chicago—Seventy-Three East Elm Building Corp., c/o McNally & Quinn, 10 South La Salle St., Archts., is having plans prepared for a 12 story apartment building at 67-75 East Elm St. Estimated cost $1,000,000.

Ill., Chicago — Youngstown Sheet Tube Co., Youngstown, O., awarded contract for a coal handling plant, etc., here. Koppers Co., Pittsburgh, Pa., is engineer.

Ill., East St. Louis — Highland Dairy Farms Co., E. F. Tschannen, Secy., 4321 Chouteau Ave., St. Louis, Mo., will soon awarded contract for the construction of a milk distributing plant including cooler building, refrigeration system, etc., at Ridge and Wimmer Sts., here. Estimated cost $150,000. N. C. Davis, 4908 Delmar Blvd., St. Louis, Mo., is architect.

Ill., Freeport—Stephenson Hotel Corp., 743 51st St., awarded contract for a 7 or 8 story hotel at Main and Galena Sts., to Robert L. Reisinger Co., 466 Oakland Ave., Milwaukee. Estimated cost $500,000.

Ill., Highland Park — City is having plans prepared for the construction of a filtration plant and pumping station. Pearse, Greeley & Hansen, 6 North Michigan Ave., are engineers.

Ill., Rockford — Syndicate, c/o Hall, Lawrence, Rippel & Ratcliffe, 123 West Madison St., Chicago, Archts., awarded contract for an 11 story hotel at State, Fourth and Market Sts., here, to Ericeson & Benson, 123 West Madison Ave., Chicago. Estimated cost $1,000,000.

La., Lake Charles—Gulf States Utilities Co., C. H. Meeks, Supt. of Plants, is having preliminary plans prepared for the construction of an 80 ton ice plant. Estimated cost including equipment $150,000. Private plans.

La., New Orleans—Jung Hotel, Canal St., awarded contract for an 18 story hotel to O. M. Gwinn, Union Indemnity Bldg. Steam heating, refrigeration and ventilation systems, boilers, pumps, elevators, etc., will be installed.

La., New Orleans — Louise Realty Co. plans the construction of a 9 story hotel at Rampart and St. Louis Sts. Estimated cost $1,000,000. Weiss & Dreyfous, Maison Blanche Bldg., are architects.

La., Olla—City, J. E. Nugent, Clk.., will soon award contract for waterworks improvements including well, reservoir, pumps, etc. F. P. Joseph, Glenmora, is engineer.

Md., Baltimore — Gillet Realty Co., c/o Wyatt & Nolting, Keyser Bldg., Archts., is having plans prepared for the construction of a 12 story apartment building at 3908 North Charles St. Estimated cost $1,200,000.

Mass., Arlington (Boston P. O.)—Edison Electric Illuminating Co., 39 Boylston St., Boston, awarded contract for the construction of a sub-station of Mystic St., here, to W. H. Bailey Co., 88 Broad St., Boston. Estimated cost $40,000.

Mass., Boston — Commonwealth Ice & Cold Storage Co., A. L. Parker, 220 Northern Ave., South Boston, awarded contract for addition to fish handling plant to W. T. Reed Co., 210 Devonshire St.

Mass., Brighton (Boston P. O.)—Chiswick Realty Co., Chiswick Rd. and Commonwealth Ave., will build a 6 story apartment building. Estimated cost $700,000. S. E. Moffie, 51 Cornhill, Boston, is architect. Work will be done by separate contracts.

Mass., Dorchester (Boston P. O.)—Transit Dept., Boston, will receive bids for the construction of Ashmont sub-station on Beale St., here. Estimated cost $50,000.

Mass., Somerville (Boston P. O.)—City, L. M. Conwell, Mayor, is receiving bids for addition to high school, including central heating plant. Estimated cost $1,250,000. F. I. Cooper Corp., 172 Tremont St., Boston, is architect.

Mich., Anchorville—Township of Ira, awarded contract for the construction of a pump house in connection with new water distribution system to R. E. Townsend, 415 First National Bank, Ann Arbor. Estimated cost $23,000.

Mich., Detroit—Union Trust Co., Griswold St., awarded contract for superstructure of a 40 story office building to W. E. Wood Co., 1805 Ford Bldg. Estimated cost $8,000,000. Steam heating and ventilation systems, boilers, elevators, etc. will be installed.

Mich., Mason—Ingham County, plans the construction of a sanitarium including heating plant. Kidner & Rosenfield, 155 East 42nd St., New York, N. Y., are consulting architects.

Miss., Howell—Mississippi State Hospital Removal Improvement & Land Sale Comn., R. L. Brown, Secy., Jackson, awarded contract for the construction of a hospital including power house, etc., to I. C. Garber, Medical Bldg.

Mo., Kansas City — W. R. Jewell, 622 Chambers Bldg., is having plans prepared for a 12 story hotel at Linwood and Harrison Sts. Estimated cost $1,000,000. P. T. Drotts, Reliance Bldg., is architect.

Mo., St. Louis—Sisters of Charity of St. Vincent De Paul, 3225 Montgomery St., is having preliminary plans prepared for a 5 story hospital at Kingshighway and Spalding Ave. Estimated cost $1,000,000.

Mo., St. Louis—Syndicate, c/o E. Wagner, 18 North 8th St., is having preliminary plans prepared for an 8 story apartment including steam heating system, etc. at Skinker Rd. Estimated cost $500,000. P. J. Bradshaw, International Life Bldg., is architect.

N. J., Camden—Terminal Corp., is having plans prepared for the construction of a cold storage warehouse. Estimated cost

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$1,500,000. Moores & Dunford Inc., 110 East 42nd St., New York, N. Y., are architects and engineers.

N. J., East Orange — Seven Hundred Forty Munn Ave., Inc., W. Lunsky, Pres., 437 Central Ave., awarded contract for a 10 story apartment building to Corona Construction Co., Military Park Bldg. Estimated cost $1,000,000. Steam heating system, boilers, elevators, etc., will be installed.

N. J., Montclair—Public Service Production Co., 80 Park Pl., Newark, will build an addition to power house at 58 Valley Rd. Estimated cost $50,000. Private plans.

N. J., Newark—Owner, c/o H. F. Clark, 38 Clinton St., is having plans prepared for a 12 story apartment including steam heating system, boilers, elevators, etc., at Wequchic Park. Estimated cost $750,000.

N. J., Newark—Owner, c/o W. E. Lehman, 972 Broad St., plans a 15 story hotel and office building including steam heating system, etc., at Budge and Broad Sts. Estimated cost $1,500,000.

N. J., Shrewsbury—A. E. Fitkin, Allenhurst, plans the construction of Raleigh Fitkin Memorial Hospital at State Highway here. Estimated cost $1,000,000. Architect not selecetd.

N. Y., Binghamton — Dept. of Mental Hygiene, Capitol, Albany, will receive bids about Jan. 1 for the construction of a cold storage plant here.

N. Y., Brooklyn — Brooklyn Syndicate, c/o Sloan & Robinson, 420 Lexington Ave., New York, Archts., is having plans prepared for the construction of an apartment building, including elevators, etc., at Kingshighway and East 27th St. Estimated cost $1,000,000.

N. Y., Long Island City — Realty Construction Co., c/o Shampan & Shampan, 188 Montague St., Brooklyn, Archts., will build a 12 story office building at 41st Ave. and Hunter St. Estimated cost $1,000,000. Work will be done by separate contracts.

N. Y., New York—Clemons Realty Co., c/o J. H. Knubel, 570 7th Ave., Archt., is having plans prepared for a 25 story loft building at 347 7th Ave. C. Mayer, 31 Union Sq., is engineer.

N. Y., New York—Dept. of Public Welfare, Municipal Bldg., will soon award contract for the construction of a power house, etc., for Lincoln Hospital.

N. Y., New York—L. I. Brooks, 65 Madison Ave., Archt., will receive bids until Jan. 30 for a 30 story office and loft building at 6th Ave. and 25th to 26th Sts., for Evolution Realty Corp., c/o J. A. Fischer, 690 6th Ave. Estimated cost $6,000,000.

N. Y., New York — S. Horowitz, 1800 Davidson Ave., will build a 6 story apartment building at Stratford Ave. and East 172nd St. Estimated cost $500,000. G. Miller, 1482 Broadway, is architect. Work will be done by separate contracts.

N. Y., New York—Laneson Realty Corp., c/o Bing & Bing, 119 West 40th St., Gen. Contr., awarded contract for a 15 story apartment building at 153 East 72nd St. Estimated cost $700,000.

N. Y., New York — Lord & Taylor, 5th Ave. and 38th St., is having plans prepared for a 10 story warehouse at First Ave. and 38th St. Estimated cost $1,500,000. Starrett & Van Vleck, 393 7th Ave., are architects.

N. Y., New York—New York Telephone Co., 140 West St., plans the construction of a 7 story commercial building at 175th St. and Grand Concourse. Estimated cost $1,500,000. Voorhees, Gmelin & Walker, 101 Park Ave., are architects.

N. Y., New York—One Hundred Twelve East 83rd St. Corp., c/o Black & Hesse, 18 East 41st St., Archts., awarded contract for a 9 story office building at 83rd St. between Park and Lexington Aves., to G. Richard Davis, 10 East 41st St. Estimated cost $500,000.

N. Y., New York—J. D. Rockefeller, Jr., awarded contract for the construction of an office building at 5th Ave. and 54th St. to Marc Eidlitz & Sons, 41 East 42nd St. Estimated cost $500,000.

N. Y., New York — Tonlex Realty Co., Inc., 343 Lexington Ave., is having plans prepared for an 11 story apartment building, including elevators, etc., at 93rd St. and Lexington Ave. Estimated cost $500,000. G. A. Bagge & Sons, 157 East 44th St., are architects.

N. Y., New York—Western Union Telegraph Co., 195 Broadway, awarded contract for a 15 story office building at West Broadway, Thomas, Worth and Hudson Sts. Estimated cost $6,500,000. Voorhees, Gmelin & Walker, 101 Park Ave., are architects.

N. Y., Syracuse—Syndicate, c/o Shreve & Lamb, 11 East 44th St., Archts., awarded contract for a 12 story office building at South Salina and West Onondaga Sts., to G. Richard Davis, 10 East 40th St. Estimated cost $1,500,000 and $2,500,000.

N. Y., Yonkers—A. A. Carr, 1 Bright Pl., will receive bids about Dec. 20, for the construction of an apartment building. Estimated cost $800,000. W. Haugaard, 185 Madison Ave., New York, is architect.

N. C., Charlotte—W. T. Heath, 11 East Third St., is having plans prepared for an 8 or 10 story apartment building. Estimated cost $500,000. M. R. Marsh, Latta Arcade, is architect.

N. C., Greenville — East Carolina Teachers' College awarded contract for the construction of a new power and heating plant to Poe Piping & Heating Co. $63,149.

O., Akron—Trustees City Hospital will soon award contract for an 8 story addition to hospital on East Market St. Estimated cost $800,000. Good & Wagner, Mohawk Bldg., are architects and engineers.

O., Cincinnati—American Druggists Fire Insurance Co., 1212 Mercantile Library Bldg., will soon award contract for a 15 story office building. Estimated cost $600,000. J. G. Steinkamp & Bro., 1212 Mercantile Library Bldg., are architects.

O., Cleveland—Rainbow Hospital, M. B. Wilson, Supt., 2233 East 55th St., awarded contract for the construction of a hospital on Green Rd., to Craig-Curtiss Co., 4614 Prospect Ave. Estimated cost $600,000. Steam heating and ventilation systems, boilers, etc., will be installed.

O., Willard — Railway Ice Co. awarded contract for the construction of an ice manufacturing plant to Blaw-Knox Co., Blaw-Knox Bldg., Pittsburgh, Pa. Estimated cost $40,000.

Okla., Tulsa—A. E. Aaronson, Court Arcade Bldg., is having plans prepared for a 10 story apartment building at 9th and Boulder Sts. Estimated cost $500,000. Architect not announced.

Okla., Tulsa — A. J. Manuel, 204 West Fourth St., is having plans prepared for an 8 story hotel including steam heating and mechanical refrigeration systems, etc. Estimated cost $750,000. Cross & Duggan, 24 Nebraska Bldg., are architects.

Okla., Tulsa—R. R. Park Realty Co., Mid-Continent Bldg., is having plans prepared for a 9 story apartment building including steam heating system, etc. Estimated cost $500,000. N. E. Peters, Orear-Leslie Bldg., Kansas City, Mo., is architect.

Okla., Wewoka—Shawnee Ice Co., E. W. Hill, Pres., plans extensions and improvements to ice plant. Estimated cost including equipment $80,000. Private plans.

R. I., Bristol — Narragansett Electric Lighting Co., W. C. Bell, Mgr., Turks Head Bldg., Providence, plans the construction of power plant at Main Rd. and Gooding Ave., here.

Tenn., Cookville — City is having plans prepared for a 1,000 hp. addition to hydro-electric plant, including dam, impounding reservoir, etc. Estimated cost $200,000. J. A. Switzer, Knoxville, is engineer.

Tenn., Knoxville—Graven & Mayger, 180 North Michigan Ave., Chicago, Ill., Archts., will receive bids until Nov. 15, for the construction of a theatre for Tennessee Enterprises, Inc., Knoxville, Tenn. Estimated cost $600,000.

Tex., Galveston—R. L. White, c/o University of Texas, Austin, Archt., will soon receive bids for an addition to hospital including power plant, etc., for J. Sealy Hospital. Estimated cost $500,000.

Tex., Nocona—Texas-Louisiana Power Co. is having preliminary plans prepared for a 150 x 250 ft. power plant, 3,600 hp. capacity. Estimated cost $325,000.

Tex., San Antonio—A. Urrutia, et al, 205 North Laredo St., plans the construction of a hotel at Broadway Ave. Estimated cost $1,500,000.

Tex., Texas City — City is having preliminary plans prepared for the construction of a power plant. Estimated cost $950,000.

Va., New Market — Shenandoah Valley Estates Co., plans the construction of a hotel, club house, etc. Estimated cost $1,000,000. American Industrial Engineering Co., 90 West St., New York, N. Y., is engineer.

Wash., Bellingham—Bellingham Development Co. plans the construction of an 11 story hotel. Estimated cost $500,000. R. C. Reamer, Seattle, is architect.

Wash., Seattle—The Bon Marche, F. McDermott, Pres., will receive bids about Jan. 1, for the construction of a 5 story stores building at Third and Pine Sts. Estimated cost $5,000,000. J. Graham, Dexter Horton Bldg., is architect.

W. Va., Charleston—Capitol Hotel Site Co. awarded contract for a 12 story hotel at Lee and Dickinson Sts., to William H. Smith Co., 110 North 7th St., St. Louis, Mo. Estimated cost $750,000. Steam heating system, etc., will be installed.

W. Va., Charleston — Stock Co., A. S. Thomas, Pres., plans the construction of a 10 or 12 story hotel at Washington and Capitol Sts. Estimated cost $750,000. Architect not selected.

Wis., Wauwatosa—Bd. of Trustees, Milwaukee County Institutions, W. I. Coffey, Mgr., will receive bids until Nov. 17 for an 8 story hospital, including steam heating and ventilation systems, boilers, pumps, elevators, etc. Estimated cost $1,500,000. Van Ryn, Gelike & Armstrong, 114 Wisconsin Ave., Milwaukee, are architects.

Mexico, Reynosa, Tamaulipas—P. Clark, McAllen, Tex., is having preliminary plans prepared for the construction of a power plant. Estimated cost $40,000. Private plans.

Equipment Wanted

Air Compressor and Motor — City of Grandfield, Okla., plans to purchase an 8 x 10 in. air compressor with 25 hp. motor.

Power Plant Equipment—Lille Mill Co., Franklin, Tenn., plans to purchase equipment for 300 hp. power plant in connection with flour meal and feed mill.

Pump — City of Bolivar, Mo., plans to purchase a deep well pump for proposed extensions and improvements to waterworks. Estimated cost $35,000.

Pump, etc.—W. C. Gillette, Water Supt., Fullerton, Calif., is receiving bids for a new booster pump, automatic starters, etc., for city wells.

Pumping Equipment, Air Compressor, etc.—R. A. Parrott, Clk., Tipton, Okla., will receive bids until Nov. 11 for air lift pumping equipment, air compressor, etc., for proposed waterworks improvements.

Pumping Unit — City of Jasper, Tex., plans to purchase a pumping unit for proposed waterworks improvements. Estimated cost $110,000.

Pumps—S. H. Kent, Clk., Hamilton, Ont., will receive bids until Dec. 7, for one steam turbine driven and one Diesel engine driven centrifugal pumps for proposed waterworks improvements.

Pumps, etc.—Sewage Comn., Milwaukee, Wis., will soon receive bids for pumps, etc., for proposed improvements to sewage treatment plant. Estimated cost $25,000.

Pumps, Motors, Air Compressor, Switchboard, etc.—W. B. Guitteau, Dir. of Public Service, Toledo, O., will receive bids until Nov. 22 for four centrifugal pumps with 200 hp. motors, air compressor, switchboard, etc., for proposed sewage pumping station.

Stokers—J. Todd, Supt. Water & Light Dept., Princeton, Ill., plans to purchase four stokers, hand or automatic for 150 hp. boilers.

Turbine, etc.—City of Yakima, Wash., will receive bids until Nov. 14 for a 700 hp. turbine and other machinery for proposed pumping plant. Estimated cost $333,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

STEADINESS characterizes the present market in power-plant and electrical supplies. No price advances occurred during the last four weeks, in the materials listed here. Linseed oil is 9c. per 7½-lb. gal. below the Oct. 11 level at New York. A decline of 10c. per standard package is reported in mica-cap fuse plugs. Structural steel shapes and plates, base, Pittsburgh, are now $1.75 per 100 lb.; the price at this time last year was $2 per 100 lb., f.o.b. mill.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 68c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list, less	50%

Air—Best grade

¼-in., per ft.	3-ply....$0.34	4 ply....$0.42

Steam—Discounts from List

First grade.....40% Second grade.....40–5% Third grade.....50%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade..... 50% Second grade..... 50–10%

LEATHER BELTING—List price, 24c., per lin.ft. per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	35%
Heavy	30%

RAWHIDE LACING { For cut, best grade, 50%; 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.95
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.95
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.30
Rubber sheet	.50
Rubber sheet, wire insertion	.80
Rubber sheet, duck insertion	.60
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.35 per bbl. without bags, in carload lots, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00@20.00
Colored	9.00@13.00	12.00	12.00@17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15
New York	.15½
Cleveland (*per thousand*)	36.00

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.77½	$0.94	$0.77

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$13.75	$15.25	$15.25	$16.75
White	13.75	15.25	13.75	15.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, small, including ⅞-in. dia., list (Apr. 1, 1927) less 50-16% in full keg lots, for immdeiate delivery from warehouse stocks in Naw York and vic nity.

Structural rivets, per 100 lb.:
New York..... $5.00* Chicago... $3.60 Pittsburgh mill $2.75@$3.00

Cone-head boiler rivets, per 100 lb.:
New York..... $5.00* Chicago... $3.60 Pittsburgh mill $3.00

*Full keg lots; broken keg lots, $6.50 net.

REFRACTORIES—Prices in car-load lots, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, Soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	78.00
Commercial genuine, intermediate grade	61.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.50

COLD DRAWN STEEL—Warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Shafting and screw stock, round and hexagon	$4.00	$3.65	$3.60
Flats and squares	4.50	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts from list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	40½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	47½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	3
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouse on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38.00	17 92
1¾	.....	28 50	20 48
2	$17.33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25.50	42 50	27 04
3¼	30.25	49 50	30 67
3½	31.50	52 75	33 53
4	38.03	67 00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.
These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.
In addition to the above, standard cutting charges are as follows:
2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2¼ and 2½ in..... 6c. per cut. 3½ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$30.00 (net)	$46.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	20%
Coils to 1,000 ft	60%	30%
1,000 to 5,000 ft	65%	35%
5,000 ft. and over	67½%	38%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
½	72.07	78 63	10.21	11.63	6.46	7.03
1	103.31	113 00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92 28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714 17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$17.75
No. 16 cotton reinforced heavy		22.00
No. 18 cotton reinforced light		14.50
No. 16 cotton reinforced light		18.35
No. 18 cotton Canvasite cord		14.75
No. 16 cotton Canvasite cord		17.20
No. 16 super service cord or similar (2 wire) in 1,000 ft	$72.00	*80.00
No. 14 super service cord or similar (2 wire) in 1,000 ft	110.00	*122.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 64%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp	$0.03 ea.	$0.05	100	100
35 to 60-amp	.05 ea.	.06	100	100
65 to 100-amp	.10 ea.	.10	50	50
110 to 200-amp	.15 ea.	.15	25	50
225 to 400-amp	.30 ea.	.30	25	25
450 to 600-amp	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than standard package	22%
Standard package	40%
Discount Without Contract—Renewals:	
Less than standard package	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less than standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.65
0-30 ampere, less than standard package	2.90

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard A type bulbs:

100—130 Volt Watts	Type	Price Each	200—260 Volt Watts	Type	Price Each
				Special	
15	A 17	$0.23	25	A 19	$0.28
	General		50	A 21	.28
25	A 19	.23	100	A 23	.50
40	A 21	.23			
50	A 21	.25			
60	A 21	.25			
100	A 23	.40			

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.00	$9.30	$10.90	$17.50
12	9.95	12.50	14.50	24.60
10	13.20	16.25	18.30	31.00
8	19.10	22.50	24.00	43.00
6	.....	.....	33.75	.....
4	.....	.....	47.50	.....
2	.....	.....	66.75	.....
1	.....	.....	92.00	.....
0	.....	.....	113.00	.....
00	.....	.....	134.50	.....
000	.....	.....	161.00	.....
0000	.....	.....	191.50	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap			¾ In. Cap		
	Key	Keyless	Pull	Key	Keyless	Pull
Standard package	$0.14	$0.12	$0.20	$0.17	$0.15	$0.23
Unbroken carton	.16	.14	.21	.19	.17	.24
Broken carton	.18	.16	.24	.21	.19	.27

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots 29c. per lb
Rubber tape, ¾ in., less than 100 lb., 33c. per lb.	100 lb. lots 31c. per lb
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots 31c. per lb
Soldering paste, 2 oz. cans	$1.00 doz

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	30-5%
$50.00 list value or over	35%